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NATIONAL DAM INSPECTION PROGRAM. GREENVILLE DAM NUMBER 3 (NDI N--ETC(U)
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LEVEL II

OHIO RIVER BASIN
LITTLE SHENANGO RIVER
MERCER COUNTY

PENNSYLVANIA

NDI No. PA 01081
PENN DER No. 43-1

National Dam Inspection Program.
(NDI Number PA 01081 Penn DER 43-1)

GREENVILLE DAM NO. 3

GREENVILLE MUNICIPAL AUTHORITY

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DACW31-81-C-0027

PREPARED FOR

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
BALTIMORE, MARYLAND 21203

BY

ACKENHEIL & ASSOCIATES GEO SYSTEMS, INC.
CONSULTING ENGINEERS
1000 BANKSVILLE ROAD
PITTSBURGH, PENNSYLVANIA 15216

MARCH 1981

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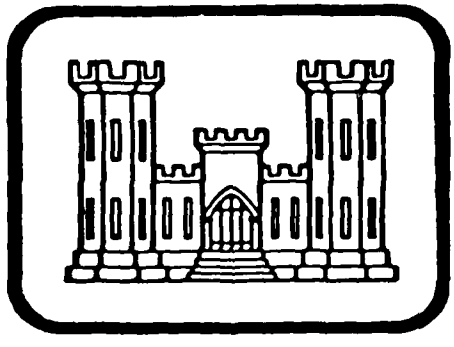
OHIO RIVER BASIN

GREENVILLE DAM No. 3
MERCER COUNTY, COMMONWEALTH OF PENNSYLVANIA
NDI No. PA 01081
Penn DER No. 43-1

GREENVILLE MUNICIPAL AUTHORITY

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



Prepared for: DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

Prepared by: ACKENHEIL & ASSOCIATES GEO SYSTEMS, INC.
Consulting Engineers
1000 Banksville Road
Pittsburgh, Pennsylvania 15216

Date: March, 1981

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams for Phase I investigations. Copies of these guidelines may be obtained fom the Department of the Army, Office of Chief of Engineers, Washington, DC 20314.

The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon visual observations and review of available data. Detailed investigations and analyses involving topographic mapping, subsurface investigations, materials testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify the need for such studies which should be performed by the owner.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of the dam depends on numerous and constantly changing internal and external factors which are evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some time in the future. Only through frequent inspections can some unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I investigations are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" (PMF) for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition, and the downstream damage potential

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

SYNOPSIS OF ASSESSMENT AND RECOMMENDATIONS

NAME OF DAM:	Greenville Dam No. 3
STATE LOCATION:	Pennsylvania
COUNTY LOCATION:	Mercer
STREAM:	Little Shenango Creek
DATE OF INSPECTION:	December 9, 1980
COORDINATES:	Lat. 41° 24.3'
	Long. 80° 21.3'

ASSESSMENT

Greenville Dam No. 3 is classified as a "small" size, "significant" hazard dam, with a recommended 1/2 PMF spillway design flood.

Based on the review and evaluation of available design information, and visual observatons of conditions as they existed on the date of the field reconnaissance, the general condition of Greenville Dam No. 3 is good.

Seeps located at both downstream embankment junctions are not considered to represent a significant hazard to the dam at this time. However, a reasonable potential exists for the seeps to develop into a significant hazard. Periodic observation of the seeps by the dam owner is advised.

Analysis using the HEC-1 Dam Safety Version computer program, indicates the spillway channel can pass a maximum of 43 percent PMF without overtopping the embankment crest. Spillway discharge capacity is assessed inadequate in accordance with guideline criteria.

RECOMMENDATIONS

The following recommendations should be implemented as soon as possible:

1. Develop and institute a flood surveillance, warning and evacuation plan.

2. Periodically observe seepage located at downstream embankment junctions. If an increase in flow quantity or evidence of erosion is observed, immediately notify the Department of Environmental Resources, Dam Safety Divison and obtain the services of a qualified professional engineer experienced in the design of dams.

3. Remove tree and woody shrub growth from embankment slopes and junctions, and along spillway channel sidewalls.

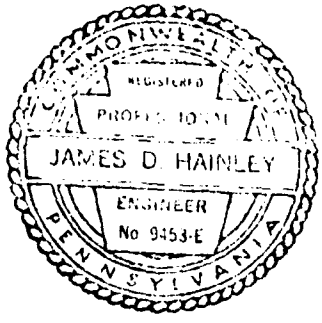
4. Backfill dam crest with suitable material, compact, and level to a grade elevation of 1144.2. Spillway capacity will then be adequate.

5. Develop and implement method for upstream closure of 18 inch diameter reservoir drain pipe.

6. Repair cracked, spalled, and deteriorated concrete surfaces on spillway channel sidewalls and bottom.

7. Backfill animal burrows on downstream embankment slope.

8. Locate and periodically monitor observation wells installed in dam embankment.



James D. Hainley, P.E.
Pennsylvania Registration No. 9453-E
Vice President

Timothy E. Debes, P.E.
Project Engineer

APPROVED BY: _____ 5 MAY 81
JAMES W. PECK DATE
Colonel, Corps of Engineers
District Engineer

GREENVILLE DAM NO. 3

OVERVIEW OF DAM

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
GREENVILLE DAM NO. 3
NATIONAL I.D. NO. PA 01081
Penn. DER No. 43-1

SECTION 1
PROJECT INFORMATION

1.1 GENERAL

A. AUTHORITY: This Phase I investigation was performed pursuant to authority granted by Public Law 92-367 (National Dam Inspection Act) to the Secretary of the Army through the Corps of Engineers, to conduct inspections of dams throughout the United States.

B. PURPOSE: The purpose of this investigation is to make a determination on whether or not the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

A. DAM AND APPURTENANCES

1. Embankment: According to available information, Dam No. 3 was constructed as a homogeneous earthfill structure with a compacted clay cutoff trench. The dam embankment measures 180 feet long (excluding spillway), 21 feet high, and has a crest width of 12 feet. The upstream embankment slope was paved with stone rubble extending from 4 to 11 feet below top of dam. The downstream embankment slope was seeded. Refer to Plate Nos. 1, 2, and 5.

2. Seepage Control Provisions: A foundation cutoff trench is located at the centerline of the dam embankment. The cutoff trench bottom was reportedly excavated to bedrock and extends between dam abutments. No other seepage control provisions are indicated by design drawings or reported in the available information.

3. Reservoir Drain: The reservoir drain consists of a gate valve controlled, 18 inch diameter, cast iron bell and spigot pipe. Flow from the drain pipe is discharged near the right abutment, into a downstream water supply reservoir. According to design drawings the reservoir drain inlet consists of a screened, 4 x 6 foot wood box.

   The pipe valve control is housed in a wood gate box, located 10 feet downstream of the embankment toe. Refer to Plate No. 4 for details.

4. Spillway Channel: The overflow spillway channel is a concrete surfaced, rectangular open channel located at the left abutment. Spillway channel length is approximately 100 feet from inlet to outlet. Channel width varies from 45 feet at the inlet, 35 feet at dam centerline, and 16 feet at the outlet. Water from the spillway channel is discharged into a downstream water supply reservoir. Refer to Plate No. 3.

B. LOCATION: Dam No. 3 is located in Hempfield Township, Mercer County, Pennsylvania approximately 1 mile northeast of the Borough of Greenville. The dam is situated across Little Shenango Creek, a north flowing tributary of the Little Shenango River which is part of the Ohio River basin.

C. SIZE CLASSIFICATION: Dam No. 3 has a maximum toe to crest height of 21 feet and a maximum storage volume of 82 acre feet at elevation 1143.9 feet. Based on the Corps of Engineers guidelines, this dam is classified as a "small" size structure.

D. HAZARD CLASSIFICATION: In the event of a dam failure, the Greenville Municipal Water Treatment Plant, and at least one inhabited dwelling located on the floodplain below the dam, would be subject to substantial damage and the loss of one or two lives could result. Damage to Route 358 is also considered possible. Dam No. 3 is therefore classified as a "significant" hazard dam.

E. OWNERSHIP: Dam No. 3 is owned by the Municipal Authority of the Borough of Greenville. Correspondence should be addressed to:

Municipal Authority
Borough of Greenville
44 Clinton St.
P.O. Box 638
Greenville, PA 16125
Attention: Mr. Fred A. Hofing
Phone No. (412) 588-4340

F. PURPOSE OF DAM: The dam was designed and constructed to provide a water supply reservoir for the Borough of Greenville.

G. DESIGN AND CONSTRUCTION HISTORY: Dam No. 3 was designed and constructed by Chester & Fleming Engineers, Union Bank Building, Pittsburgh, Pennsylvania. Actual construction of dam began July, 1913 and was completed in November of the same year.

H. NORMAL OPERATING PROCEDURE: Dam No. 3 was designed to operate as an uncontrolled structure. Under normal operating conditions, reservoir pool level is maintained at El. 1139.0 by the concrete control apron of the spillway channel. The reservoir drain gate valve is normally kept closed and subjects the 18 inch diameter drain pipe to a pressure head.

1.3 PERTINENT DATA

Note: The elevations given below are based on mean sea level and were obtained from the original design plans dated 1913. (Plates 1 to 4).

A. Drainage Area:	2.2 sq. mi.
B. Discharge at Dam Facility:	
Maximum Flood at dam facility	Dam overtopped during Hurricane Hazel 1954
Spillway capacity at top of dam	
Existing	1234 cfs
Design	1272 cfs

C. Elevation (feet above MSL)

Design top of dam	1144.0
Existing top of dam (minimum)	1143.9
Spillway crest	1139.0
Normal pool	1139.0
Reservoir drain inlet invert	1127 ±
Reservoir drain outlet invert	1125 ±
Downstream embankment toe	1121 ±

D. Reservoir Length

Length of maximum pool	2500 feet
Length of normal pool	1200 feet

E. Reservoir Storage

Existing top of dam	82 acre-feet
Spillway crest	42 acre-feet
Normal pool	42 acre-feet
Sediment Pool	Unknown

F. Reservoir Surface

Existing top of dam	12 acres
Spillway crest	5 acres
Normal pool	5 acres
Sediment pool	Unknown

G. Embankment

Type	Earthfill
Length	180 feet
Height	
Design	21.0 feet
Existing	20.9 feet
Crest width	12 feet
Slopes	
Downstream	2.5H:1V
Upstream	3H:1V
Impervious core	No
Cutoff provisions	Yes-clay and concrete cutoff walls
Grout curtain	No

H. Spillway Channel

Type	Rectangular concrete channel
Width	35 feet at dam centerline
Length	100 feet
Approach Channel Slope	Unknown
Discharge Channel Slope	4.5 percent
Gate	None

I. Reservoir Drain

Type	18 inch diameter cast iron pipe
Upstream flow control	No
Length	90 feet
Anti-seep collars	Yes
Valve control	18 inch diameter gate valve located 10 feet downstream of dam.

SECTION 2
ENGINEERING DATA

2.1 DESIGN

A. DATA AVAILABLE: The following written information and data may be obtained from the Pennsylvania Department of Environmental Resources, Harrisburg, Pennsylvania.

1. Miscellaneous correspondence dating from January 17, 1913 to June 5, 1913 related to permit application requirements, review of existing reservoirs, and proposed design plans.

2. "Report on the Application of the Greenville Water Company" for permission to construct a dam on a tributary of the Little Shenango River, dated June 5, 1913, with Supplementary Report dated July 10, 1913.

3. Miscellaneous correspondence related to dam construction, and construction inspection of Dam No. 3, dating from July 15, 1913 to January 14, 1915.

4. Miscellaneous correspondence and Inspection Reports related primarily to the presence of seeps at both downstream embankment junctions, dating from January 14, 1913 to June 3, 1952.

5. Four (4) design drawings by Chester and Fleming Consulting Engineers, Union Bank Building, Pittsburgh, Pennsylvania, dated May 5 and October 16, 1913.

6. Drawing by Water Supply Commission of Pennsylvania, entitled, "Investigation of Dam of Greenville Water Company." Date unknown.

B. DESIGN FEATURES: The design criteria used to construct the dam embankment in 1913 is unknown. Principal design features are illustrated on Plate Nos. 1, 2, 3 and 4.

1. Field Investigation: No information was available indicating a predesign geotechnical investigation was performed at the dam site.

2. Embankment: The homogeneous earthfill embankment reportedly consists predominately of clay, spread in 6 inch layers, dampened and compacted. According to design plans, the dam embankment rests on stiff impervious clay and shale rock. Earthfill was obtained from on site borrow sources and from a breached wood-crib dam that had been previously sited at the same location. The upstream and downstream embankments were designed to be constructed on 2H:1V inclinations.

3. Seepage Control Provisions: The foundation cutoff trench was constructed with a varying base width, ranging between 4 and 6 feet, and vertically excavated side slopes. The cutoff trench was extended 4 to 5 feet deep to shale bedrock, and was backfilled with puddled clay. The cut-off trench extends from underneath the spillway channel at the left abutment to the right abutment.

4. Reservoir Drain: Reservoir drain pipe is located about 50 feet left from the right abutment. The 18 inch diameter cast iron pipe was reportedly supported on compacted earthfill and shale rock, and was constructed with 6 anti-seep collars, spaced at 12 feet intervals. The concrete collars measure 6 feet square, 12 inches thick, and were constructed with steel reinforcement. The drain pipe is regulated by a hand-operated gate valve, located in a 5 x 6 x 5.7 feet valve pit, near the toe of the downstream embankment. The water in the reservoir drain pipe is under pressure due to the gate valve being located downstream of the dam. A 10 inch diameter cast iron pipe, which serves as a water supply pipeline, is connected to the reservoir drain pipe immediately upstream of the gate valve. This pipeline feeds directly to the Water Treatment Plant, located 550 feet below the dam and is frequently in service.

5. Spillway Channel: The spillway channel was reportedly excavated to shale and sandstone bedrock at the left abutment. Spillway channel sidewalls and bottom are constructed of 12 inch thick reinforced concrete and 6 inch thick non-reinforced concrete, respectively. Channel wall height varies from 5.25 feet at dam centerline to 3.7 feet at spillway inlet and outlet channel sections. The outlet channel section has a positive 4.5 percent slope and a 1.5 foot drop step,located about 17 feet downstream of the spillway inlet. The spillway channel outlet consists of a 3 foot outfall drop and an excavated sandstone channel. The sandstone channel slopes 6.7 percent and discharges into a downstream water supply reservoir.

2.2 CONSTRUCTION

A. CONTRACTOR AND CONSTRUCTION PERIOD: Chester & Fleming Consulting Engineers, Pittsburgh, Pennsylvania constructed Dam No. 3 between July, 1913 and November of the same year.

B. FIELD CHANGES: As a result of the spillway being founded entirely on shale and sandstone rock, the concrete channel bottom was reduced in thickness from 12 to 6 inches, including omitting the steel reinforcement.

C. CONSTRUCTION INSPECTION AND SUPERVISION: On-site inspection was performed by E. E. Haslam Field Engineer, of the Water Supply Commission of Pennsylvania, periodically during construction. W. T. Mclenahen served as the full time Engineer-in-Charge for Chester & Fleming Consulting Engineers.

2.3 MODIFICATION: Seeps developed at both downstream embankment junctions when Dam No. 3 reservoir was first filled in November, 1913. The condition persisted, and in 1928, 2 feet thick concrete cutoff walls were constructed immediately upstream of the dam embankment at each abutment. The cutoff walls were extended to shale bedrock and extend 85 feet and 28 feet from the left and right abutments respectively.

2.4 OPERATION: The Municipal Authority of the Borough of Greenville is responsible for the operation of Dam No. 3. The spillway channel was designed as an uncontrolled structure and performance and operation records are not maintained. The reservoir drain gate valve is infrequently used and is normally closed. The dam does not require a dam tender.

2.5 EVALUATION

A. AVAILABLITY: Available design information and drawings were obtained from the Pennsylvania Department of Environmental Resources, Dam Safety Division, Harrisburg, Pennsylvania.

B. ADEQUACY: The available design information and drawings supplemented by engineering analysis presented in succeeding sections, is adequate for the purpose of this Phase I study.

C. VALIDITY: Based on the available data, there appears to be no reason at this time to question the validity of the available design information and drawings.

SECTION 3
VISUAL INSPECTION

3.1 FINDINGS

A. GENERAL: The field reconnaissance of Dam No. 3 was performed on December 9, 1980 and consisted of:

1. Visual observation of the embankment crest and slopes, abutments, and surficial conditions.

2. Visual observation of the spillway channels, outfall, reservoir shoreline, and watershed.

3. Visual observation of downstream conditiors and evaluation of the downstream hazard.

4. Transit stadia survey of relative elevations along the embankment crest centerline, spillway, and across the embankment slopes.

Visual observations were made during a period when reservoir and tailwater pools were at normal operating levels.

The visual observatons checklist, field plan, profile, and section are presented in Appendix A. Specific observations are illustrated on photographs in Appendix C.

B. EMBANKMENT

1. Embankment Surface: Embankment crest, slopes and abutments had a dense grass covering and appeared stable. Rock riprap extended from normal pool level 4 feet below top of dam on the upstream embankment slope. No tension cracks or settlement conditions were observed in the crest or slopes. Tree and woody shrub growth were observed at several locations on dam abutments, embankment junctions, and embankment slopes.

Three (3) animal burrows were noted on the downstream embankment slope, near the right abutment, at the location of the reservoir drain outlet.

Field survey measurements indicated the upstream and downstream embankment slopes are inclined 3H:1V and 2.5H:1V respectively, and not 2H:1V as shown on design drawings. No erosion or sloughing of embankment slopes was evident. Refer to Photograph Nos. 1, 2, 3, and 4.

2. Seepage: Seepage zones were observed at both downstream embankment junctions near normal tailwater level (El. 1126.5). The seepage zones were small in surface area and had estimated flow rates of about 2 gpm. No soil fines or eroded channels were evident at either discharge. Refer to Photograph Nos. 3 and 4 for location of seeps. A spring was observed approximately 75 feet downstream of the right abutment at about tailwater level. The spring had a clear discharge of about 4 gpm.

C. APPURTENANT STRUCTURES

1. Reservoir Drain: Reservoir drain inlet, pipe, and outlet were submerged and/or buried and could not be observed. The 18 inch gate valve, which regulates pipe flow, is located downstream of the dam and is infrequently operated. The Greenville Municipal Water Authority reports the gate valve is operational.

2. Spillway Channel: The spillway inlet channel consisted of a reinforced concrete apron at the left abutment. Field survey measurements verified design drawing apron widths of 45 feet at channel inlet and 35 feet at dam centerline. The spillway channel converges to a width of 16 feet approximately 85 feet below dam centerline. Some brush and wood debris were partially obstructing the free flow of water into the spillway channel. Cracking and spalling was noted on the channel bottom and sidewalls at several locations. (Refer to Photgraphs No. 5 and 6). The right spillway channel endwall is severly deteriorated as shown by Photograph No. 7. The right spillway channel sidewall appears slightly tilted toward the open channel. However, observation of the backfill behind the wall revealed no indication of recent tension cracks or wall movement. No seep holes were observed in either channel sidewall.

D. DOWNSTREAM CONDITIONS

1. Downstream Channel: Spillway channel flow is discharged into a downstream water supply reservoir located immediately below the dam. This 6 acre-feet reservoir empties into the Little Shenango Creek at the State Route 358 bridge overpass, located 500 feet below the dam. The bridge underpass measures 10 feet high by 18 feet wide. Little Shenango Creek below State Route 358 is unobstructed for a distance of 1000 feet and [illegible]

2. Floodplain Development: The Borough of Greenville Water Treatment Plant is located about 550 feet directly below the dam. This facility is situated at a low enough elevation to be affected by a dam failure. Also, State Route 358, a major east-west highway would be threatened by failure of the dam.

   Approximately 1.1 miles below the dam, at least one inhabited dwelling is located in the floodplain, within a 100 foot distance of the stream channel.

E. RESERVOIR

1. Slopes: Reservoir slopes have mild to moderate inclinations and are heavily forested. The shoreline is moderately steep and generally vegetated around its entire length. No significant evidence of slope or shoreline erosion or instability was observed

2. Sedimentation: No significant indications of sedimentation were observed during the field reconnaissance. The Greenville Muncipal Water Authority reports most of the watershed area is not cultivated or developed, and only small quantities of sediment enter the reservoir.

3. Watershed: Visual observations and a review of the Greenville East U.S.G.S. quandrangle map indicate the watershed cover complex consists predominately of forest, open field, and some rural development.

A small pond (less than 5 acre feet) is located approximately 1.4 miles upstream of Dam No. 3.

3.2 EVALUATION

A. EMBANKMENT

1. Embankment Surface: In general, embankment crest and slopes are reasonably maintained and appear in good condition. The observed deficiencies, consisting of tree and woody shrub growth and animal burrows, are surficial in scope and are not considered significant relative to the overall stability of the dam at this time. However, these deficiencies should be corrected as soon as possible.

2. Seepage: According to the available information, the seepage observed at both downstream embankment junctions has existed since the filling of the reservoir in 1913. It was believed at that time that the seepage originated from water flowing through the fractured shale bedrock and under, or around, the cutoff trench. In 1928, 2 feet thick concrete cutoff walls were constructed at both upstream abutment junctions in an effort to stop the seepage. The cutoff walls were extended from normal pool level to shale bedrock. The left and right cutoff walls were extended 85 feet and 28 feet respectively from each abutment. Correspondence dating to June 3, 1952 indicates the seepage had continued unabated after the above cutoff walls were constructed.

   The exact cause and origin of the seepage could not be conclusively established by visual observation and review of construction documents. However, based on the history of the seeps, the corrective repairs made, and the observed spring activity downstream of the right abutment, the seeps are assumed to originate from the fractured shale rock, and are not considered to represent a signficant hazard to the dam at this time. However, the seeps should be periodically observed as a precautionary measure.

B. RESERVOIR DRAIN: The reservoir drain was submerged and could not be observed. However, the Greenville Municipal Water Authority reports the drain pipe and gate valve are in good condition. The water in the reservoir drain pipe is under pressue due to the gate valve being located near the downstream embankment toe. Leakage from this pipe could result in internal erosion of the embankment and possible instability.

C. SPILLWAY CHANNEL: The spillway channel was observed to be in fair condition, [illegible] and deteriorated concrete sidewall and bottom surfaces should be repaired, debris removed from spillway approach channel, and tree and woody shrub growth removed from the spillway - embankment junction and along channel sidewalls.

D. HAZARD POTENTIAL: Based on observations of downstream conditions, Dam No. 3 was assigned a "significant" hazard potential rating.

SECTION 4
OPERATIONAL FEATURES

4.1 PROCEDURE: Normal operating procedure does not require a dam tender. Reservoir pool level is maintained by the control apron of the spillway channel. The reservoir drain gate valve is normally closed. However, a 10 inch diameter water supply pipe and gate valve, fed off the 18 inch diameter reservoir drain pipe, is frequently in service.

4.2 MAINTENANCE OF DAM: The dam embankment and appurtenances are maintained by the Borough of Greenville Municipal Authority. Maintenance reportedly consists of periodically mowing embankment crest and slopes, removing debris from spillway, and repairing eroded surfaces. Maintenance is routinely performed on an as-needed basis.

4.3 INSPECTION OF DAM: The dam is visited daily by an employee of the Muncipal Authority to inspect the dam and observe reservoir pool levels. Available records indicate that the dam was inspected by state personnel in 1913, 1917, 1920, 1925, 1929, 1932, 1935, 1940, and 1952.

4.4 WARNING SYSTEM: There is no warning system or formal emergency procedure to alert or evacuate downstream residents upon threat of a dam failure. However, the Municipal Authority superintendent reports the dam is monitored during periods of heavy rainfall and local police authorities would be contacted in case of an emergency.

4.5 EVALUATION: Inspection and maintenance procedures at Dam No. 3 are considered adequate. However, a more thorough maintenance program is recommended for gate valve mechanisms, and tree removal. Formal flood surveillance, warning, and evacuation plans should be developed and implemented for the protection of downstream residents.

SECTION 5
HYDROLOGY AND HYDRAULICS

5.1 EVALUATION OF FEATURES

A. DESIGN DATA: Dam No. 3 has a watershed of 1408 acres, vegetated primarily by forest and open field. The dam impounds a 5 acre water supply reservoir with an estimated normal pool storage volume of 42 acre-feet and an existing top of dam storage volume of 82 acre-feet. Normal pool level is maintained at El. 1139.0 by the spillway channel control apron.

Design information indicates the spillway channel has a maximum discharge capacity of 660 cfs when reservoir pool level is 3 feet above spillway crest elevation. No additional hydrologic calculations were available relating reservoir - spillway performance to a designated spillway design flood.

B. EXPERIENCE DATA: Records are not kept of reservoir stage elevations or rainfall amounts. However, during Hurricane Hazel, the reservoir reportedly rose about 0.5 feet above top of dam (El. 1144.5) at the right abutment. This overtopping resulted in the washout of about 1 foot of embankment crest material at the right abutment and some embankment fill along the embankment-spillway junction.

C. VISUAL OBSERVATIONS: No serious deficiencies or other adverse conditions were observed during the field reconnaissance that would significantly reduce spillway discharge capacity or prevent the channel from functioning as designed. However, cracked, spalled, and deteriorated concrete surfaces were observed on channel bottom and sidewalls.

D. OVERTOPPING POTENTIAL: The U.S. Army Corps of Engineers dam safety guidelines recommend design storms of 100 year to 1/2 PMF (Probable Maximum Flood) for "small" size, "significant" hazard dams. Based on the evaluation of the downstream hazard potential, a 1/2 PMF spillway design flood is considered appropriate.

The 1/2 PMF inflow hydrograph for Dam No. 3 was modeled utilizing the HEC-1 Dam Safety Version computer program. This hydrograph was routed through the spillway channel and yielded a 1/2 PMF outflow rate of 1358 cfs.

Varying percentages of the spillway design flood were routed through the spillway channel to estimate the percent PMF outflow that can be passed without overtopping the dam embankment. HEC-1 Dam Safety version computer analysis indicated the spillway can hydraulically pass a maximum of 43 percent PMF without overtopping. (Based on existing top of dam elevation 1143.9). The analysis further indicates that Dam No. 3 is overtopped by a maximum of 0.28 feet for a duration of 3.5 hours for 1/2 PMF conditions. Routing analyses also indicate if top of dam is raised to elevation 1144.2, the spillway channel can pass the spillway design flood without overtopping the dam embankment. A summary of the hydrologic/hydraulic analysis, including supporting calculations, is presented in Appendix D.

E. ADEQUACY OF SPILLWAY CHANNEL: Spillway adequacy was evaluated in accordance with procedures and guidelines established by the U.S. Army Corps of Engineers for Phase 1 hydraulic and hydrologic studies. The recommended spillway design flood (SDF) is 1/2 PMF.

Routing analysis indicates the spillway channel has a maximum discharge capacity of 1177 cfs (based on current top of dam elevation) or about 43 percent PMF. According to guideline criteria, Dam No. 3 spillway capacity is inadequate.

F. DOWNSTREAM CHANNEL: Outflow from the spillway channel is discharged into a water supply reservoir of 6 acre-feet located immediately below the dam. Flow from this reservoir is discharged under State Route 358 into an overexcavated stream channel partially lined with riprap. This improved channel empties into the natural stream channel of Little Shenango Creek approximately 1500 feet below the dam. Little Shenango Creek has a channel gradient of about 1.5 percent and a width varying between 5 and 18 feet. The creek meanders approximately 2.3 miles to its confluence with the Little Shenango River. The Borough of Greenville Water Treatment Plant and at least one inhabited dwelling, are expected to be subject to damage and the possible loss of one or two lives in the event of a dam failure.

SECTION 6
STRUCTURAL STABILITY

6.1 AVAILABLE INFORMATION

A. DESIGN AND CONSTRUCTION DATA

1. Subsurface Exploration: The available information did not reference to any subsurface exploration being conducted prior to dam construction. However, a general conditions report indicates the dam embankment was to be construced on top of stiff clay and/or shale rock.

2. Laboratory Testing: No reference to laboratory testing was found from available information sources.

3. Slope Stability Analysis: No calculations or references were found of structural or slope stability analysis from the available design information.

B. OPERATING RECORDS: There are no written operating records or procedures for Dam No. 3.

C. POST-CONSTRUCTION CHANGES: In 1928, 2 feet thick concrete cutoff walls were constructed at both upstream abutments to stop the seepage of water emanating from the junctions of the downsteam embankment. The cut off walls were extended 85 feet and 28 feet from the left and right abutments respectively.

In 1954, flood waters from Hurricane Hazel washed out a 15 foot wide area of the dam crest, about 1 foot deep, at the right abutment and some embankment fill along the embankment-spillway junction. These areas were backfilled, graded and seeded.

D. PERFORMANCE: Records indicate the seepage observed at the downstream embankment junctions has existed since filling of Dam No. 3 reservoir in November, 1913. Reports also indicate the seepage flow has remained relatively constant and clear, and has not caused any structural instability over the 67 year life of the dam.

6.2 EVALUATION

A. DESIGN DOCUMENTS: The design documentation was considered inadequate to evaluate the dam structure. No structural or stability calculations were available for review.

B. VISUAL OBSERVATIONS

1. Embankment: Field observation of seepage emanating from both downstream embankment junctions was not adequate to ascertain the exact cause and origin of the seepage. However, the seepage was clear and there was no evidence of piping or erosion channels. Although the seepage has remained constant since 1913, progressive erosion of the shale bedrock under the dam or around abutments could reasonably develop into a potential hazard. It is recommended as a precautionary measure that the Greenville Municipal Authority continue to periodically observe the seeps to note any change of conditions.

In general, the structural condition of the dam appears good at the present time.

2. Spillway Channel: Visual observation of the spillway channel did not reveal evidence of major structural deficiencies that would significantly affect hydraulic perfomance or dam stability. However, the cracking, spalling and deterioration observed on concrete channel sidewalls and bottom surfaces is in need of immediate repair.

C. SEISMIC STABILITY: According to the Seismic Risk Map of the United States, Dam No. 3 is located in Zone 1 where damage due to earthquakes would most likely be minor.

A dam located in Seismic Zone 1 may be assumed to present no hazard from an earthquake provided static stability conditions are satisfactory and conventional safety margins exist. However, no calculations were developed to verify this assessment.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS

7.1 ASSESSMENT

A. EVALUATION

1. Embankment: The cause and origin of the seeps located at both downstream embankment junctions could not be conclusively established by visual observation and review of the construction drawings. Although the seeps are not considered to represent a significant hazard to the dam at this time, a reasonable potential exists for the seeps to develop into a hazard and hence, warrant periodic observation by the dam owner.

   In general, Dam No. 3 is considered to be in good condition. This is based on visual observation that revealed only minor deficiencies.

2. Reservoir Drain: The reservoir drain could not be observed and condition assessed. However, the Greenville Municipal Authority reports the drain and gate valve to be in good, operable condition.

3. Spillway Channel

   a. Condition: The condition of the spillway channel is considered to be fair. This is based on the observation of cracked, spalled and deteriorated concrete surfaces on channel sidewalls and bottom.

   b. Adequacy: HEC-1 Dam Safety Version routing analysis indicates Dam No. 3 spillway can hydraulically pass 43 percent PMF. The recommended spillway design flood (SDF) is 1/2 PMF. Spillway discharge capacity is therefore assessed inadequate in accordance with U.S. Army Corps of Engineers dam safety criteria.

B. ADEQUACY OF INFORMATION: The design, construction, operation and performance history information available was sufficient to evaluate the embankment and appurtenant structures in accordance with the Phase I investigation guidelines.

C. NECESSITY FOR FURTHER INVESTIGATION: The observed condition of Greenville Dam No. 3, as it presently exists, does not require additional investigation.

D. URGENCY: The following recommendations should be implemented as soon as possible.

7.2 RECOMMENDATIONS

A. DAM AND APPURTENANT STRUCTURES

1. Periodically observe seepage located at downstream embankment junctions. If an increase in flow quantity or evidence of erosion is observed, immediately notify the Department of

Environmental Resources, Dam Safety Division and obtain the services of a qualified professional engineer experienced in the design of dams.

2. Remove tree and woody shrub growth from embankment slopes and junctions, and along spillway channel sidewalls.

3. Backfill dam crest with suitable material, compact and level to a grade elevation of 1144.2 feet. Spillway capacity will then be adequate.

4. Develop and implement method for upstream closure of 18 in. diameter reservoir drain pipe.

5. Repair cracked, spalled and deteriorated concrete surfaces on spillway channel sidewalls and bottom.

6. Backfill animal burrows on downstream embankment slope.

B. OPERATION AND MAINTENANCE PROCEDURES

1. Develop an emergency operation and warning plan. Plan should include, but not limited to, the following:

   a. Surveillance: Procedures for around the clock surveillance during periods of heavy precipitation or runoff.

   b. Warning System: Procedures for notifying downstream residents and local police authorities in the event of expected high flood flows.

   c. Evacuation Plans: Emergency contingency plans to evacuate downstream residents upon the threat of a dam failure.

2. Locate and periodically monitor observation wells installed in dam embankment. Refer to Plate No. 5.

APPENDIX A

VISUAL OBSERVATIONS CHECK LIST AND FIELD SKETCH

VISUAL OBSERVATION CHECK LIST

Name Dam Greenville Dam No. 3 County Mercer State Pennsylvania National ID # PA 01081

Type of Dam Earthfill Hazard Category Class II - Significant

Date(s) Inspection 12/9/80 Weather Cloudy-Rain Temperature 40°F±

Inspection Review Date 12/19/80

Pool Elevation at Time of Inspection *1139 Tailwater at Time of Inspection 1126.5 M.S.L.

Inspection Personnel:		
J. D. Hainley, P.E.	Ackenheil & Associates	Supervising Principal
T. E. Debes, P.E.	Ackenheil & Associates	Project Manager and Hydrologist
P. A. D'Amato, P.E.	Ackenheil & Associates	Geotechnical Engineer
F. A. Hofing	Greenville Municipal Authority	Superintendent
P. Canale	Greenville Municipal Authority	
H. Thompson	Greenville Municipal Authority	

Recorder P. A. D'Amato, P.E.

*Pool level 1 inch above spillway crest.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS*
SURFACE CRACKS	No surface cracks were observed. Embankment crest and slopes have a dense grass covering.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	No significant sloughing or erosion was observed.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	No significant vertical or horizontal misalignment observed or revealed by transit survey of crest and dam profile.	
RIPRAP FAILURES	Riprap placed on upstream embankment slope mostly covered by grass.	

*REFER TO REPORT SECTIONS 3 AND 7

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SETTLEMENT	None observed.	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Animal burrows noted at right downstream embankment - abutment junction. Tree and woody shrub growth observed at embankment - spillway junction and embankment - abutment junction.	
ANY NOTICEABLE SEEPAGE	Seeps located at both downstream embankment junctions near tailwater pool level. Observed seepage free of fines, with flow rates of about 2 gpm. Spring located 75 feet downstream of right abutment near tailwater pool level.	
STAFF GAGE AND RECORDER	Rain gauge located at Water Treatment Facility. Records maintained since 1977.	
DRAINS	There are no embankment drains associated with this dam.	

OUTLET WORKS

RESERVOIR DRAIN

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	N/A - Reservoir drain constructed of cast iron pipe.	
INTAKE STRUCTURE	Drain inlet, pipe, and outlet structures were submerged and/or buried and could not be observed. Control valve located at downstream embankment toe.	
OUTLET STRUCTURE	See above.	
OUTLET CHANNEL	Reservoir drain pipe outlets into a water supply reservoir located immediately below the dam embankment.	
EMERGENCY GATE	None.	

UNGATED SPILLWAY CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	N/A	
APPROACH CHANNEL	Spillway approach channel consists of a concrete control apron approximately 17.5 feet long with a varying channel width, ranging from 45 feet at the inlet to 35 feet at dam centerline. Wood debris located just upstream of spillway channel. Channel bottom and sidewalls show evidence of temperature and freeze-thaw cracking and spalling.	
DISCHARGE CHANNEL	The discharge channel ranges in width from 35 feet at dam centerline to 16 feet at the outfall. Cracking, spalling, and general deterioration of concrete was evident over most of the concrete channel sidewalls and bottom. Right spillway sidewall end section severely deteriorated.	
BRIDGE AND PIERS	None.	

INSTRUMENTATION

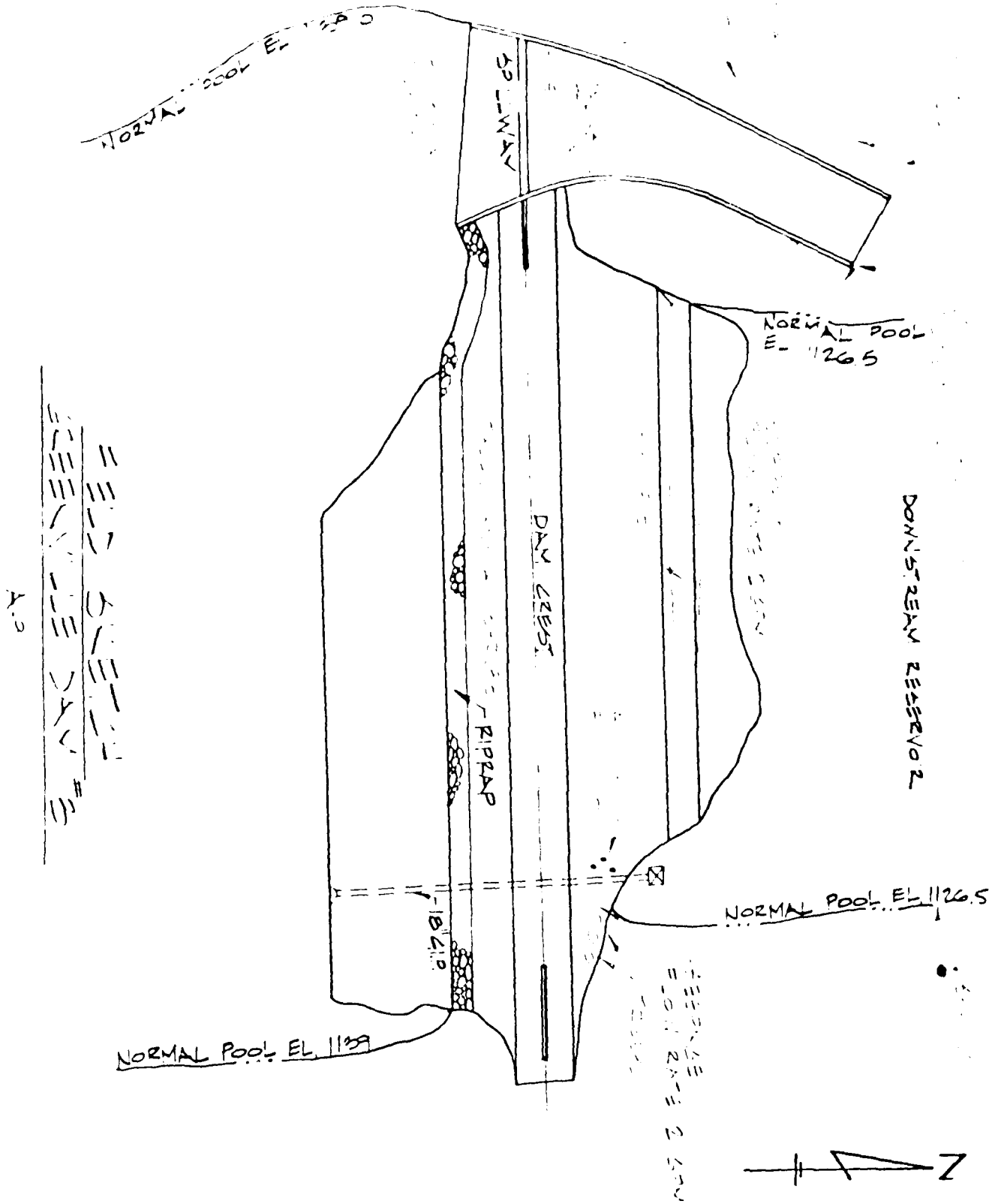
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	Survey marker of unknown elevation located on State Route 358 bridge overpass. Bridge located 500 feet downstream of dam.	
OBSERVATION WELLS	Cast iron stand pipe located at mid slope of downstream embankment, near the embankment spillway junction. Pipe clogged with debris.	
WEIRS	None.	
PIEZOMETERS	None.	
OTHER	N/A	

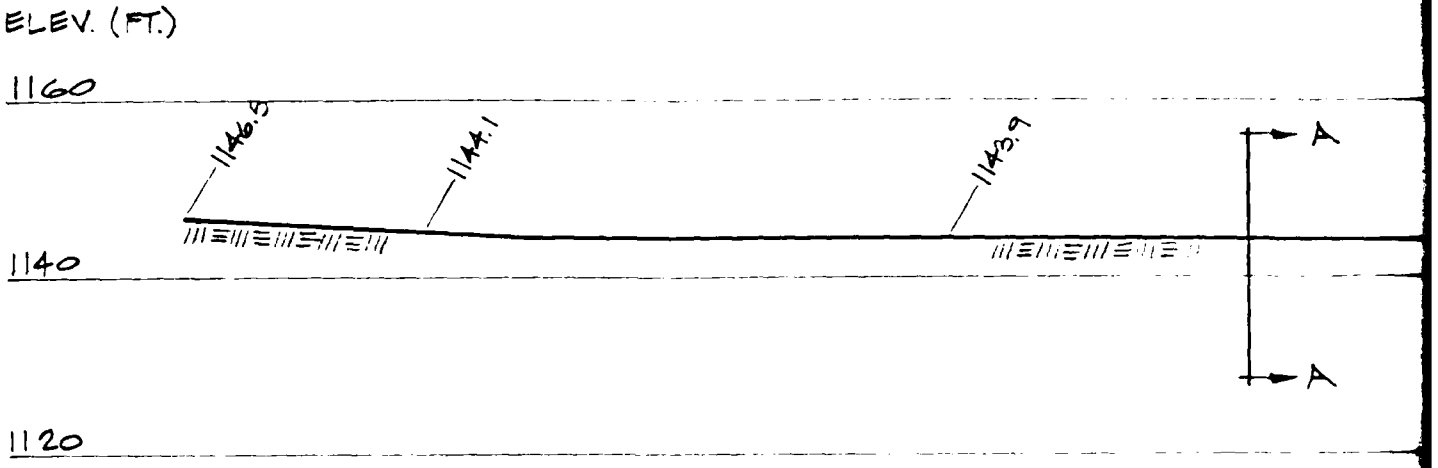
RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Slopes in the immediate vicinity of the reservoir were observed to have mild to moderate inclinations with a heavy forest cover. No indications of significant embankment sloughing or shoreline erosion was evident.	
SEDIMENTATION	None observed. Upstream watershed area partially controlled by Municipal Authority. Watershed includes little rural development or cultivated land. Reservoir reportedly predominately spring fed.	

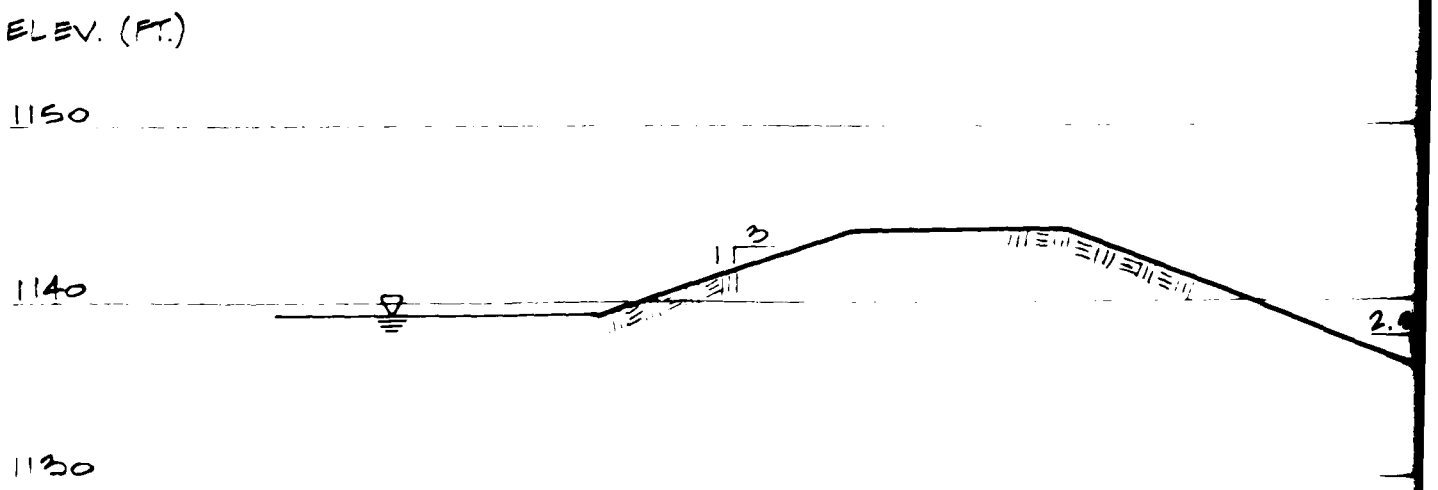
DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	No significant debris or flow obstructions observed within 1500 feet of dam embankment.	
SLOPES	Channel immediately downstream of dam overexcavated and partially lined with riprap. Channel width relatively narrow, with moderate to steep side slopes.	
APPROXIMATE NO. OF HOMES AND POPULATION	Water treatment facility located 550 feet below dam. Approximately 1.1 miles downstream, at least one inhabited dwelling is located in the estimated floodplain.	

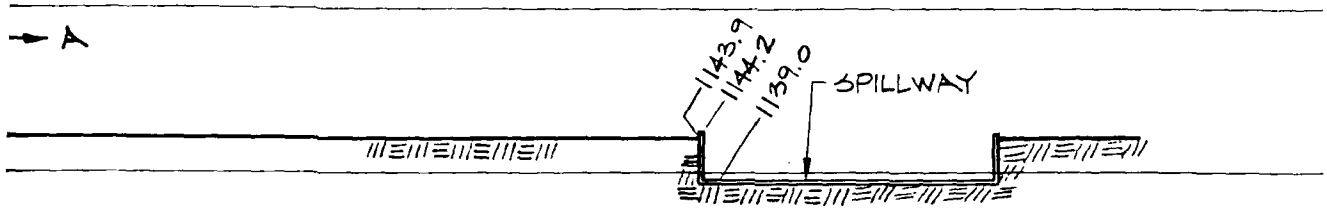

NORMAL POOL EL 1126.5
SPILLWAY
NORMAL POOL EL 1126.5
DAM CREST
RIPRAP
DOWNSTREAM RESERVOIR
NORMAL POOL EL 1126.5
NORMAL POOL EL 1139



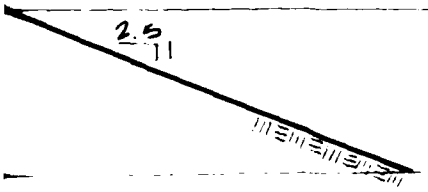
DAM CREST PR
1" = 20'



SECTION A-A
1" = 10'



EST PROFILE - LOOKING UPSTREAM



DATE: MARCH 3, 1981	GREENVILLE DAM #3 NATIONAL DAM INSPECTION PROGRAM	DAM CREST PROFILE AND SECTION
SCALE: AS SHOWN		
DR: JV CK: TED	ACKENHEIL & ASSOCIATES CONSULTING ENGINEERS PITTSBURGH, PA., CHARLESTON, W. VA. & BALTIMORE, MD.	
DWG NO A 0		

APPENDIX B

CHECK LSIT
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE 1

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE 1

NAME OF DAM Greenville Dam No. 3

ID # PA 01081

ITEM	REMARKS
AS-BUILT DRAWINGS	No as-built drawings are available. Design drawings were provided by the Pennsylvania Department of Environmental Resources, Dam Safety Division, Harrisburg, Pennsylvania.
REGIONAL VICINITY MAP	See Appendix E. U.S.G.S. 7.5 minute Pennsylvania Quadrangle Map showing dam site location.
CONSTRUCTION HISTORY	Design plans approved June 23, 1913. Application to construct dam approved July 15, 1913. Actual construction of dam began July, 1913 and was completed November, 1913. Dam designed and constructed by Chester & Fleming Engineers, Union Bank Building, Pittsburgh, Pennsylvania.
TYPICAL SECTIONS OF DAM	See Plates No. 1 and 2.
OUTLETS - PLAN DETAILS CONSTRAINTS DISCHARGE RATINGS	See Plate No. 4 for details of reservoir drain pipe control valve.
RAINFALL/RESERVOIR RECORDS	Rainfall records available from 1977. Records maintained at Greenville Municipal Water Treatment Facility.

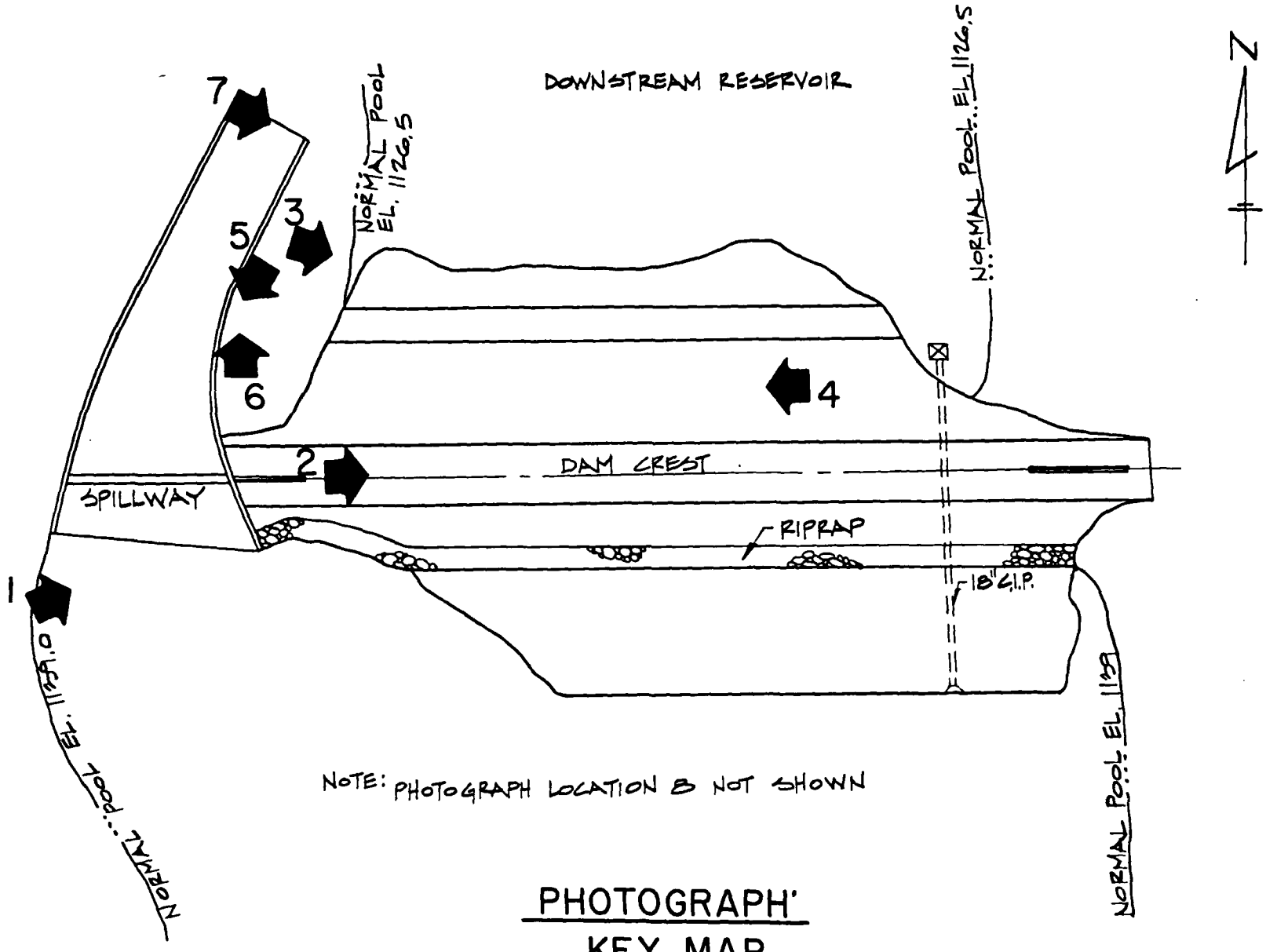
ITEM	REMARKS
DESIGN REPORTS	Design report summary dated May 15, 1913, addressed to State Department of Health, Harrisburg, Pennsylvania.
GEOLOGY REPORTS	None available.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Spillway capacity calculations presented in letter dated June 5, 1913, addressed to Water Supply Commission of Pennsylvania.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None available.
POST-CONSTRUCTION SURVEYS OF DAM	None reported.
BORROW SOURCES	Borrow reportedly obtained from on-site sources.

ITEM	REMARKS
MONITORING SYSTEMS	None reported or operative.
MODIFICATIONS	In 1928, concrete cutoff walls were constructed upstream of the dam embankment. No drawings were available.
HIGH POOL RECORDS	Flood waters from Hurricane Hazel overtopped dam embankment by approximately 0.5 feet. Pool level elevation about 1145 feet.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None available
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	Small section of dam crest and spillway - embankment junction washed out during Hurricane Hazel.
MAINTENANCE OPERATION RECORDS	None available.

ITEM	REMARKS
SPILLWAY PLAN	
SECTIONS	See Plate No. 3 for details and section view.
DETAILS	
OPERATING EQUIPMENT PLANS & DETAILS	See Plate No. 4 for details of reservoir drain gate valve.
SPECIFICATIONS	None available.
MISCELLANEOUS	See Report Section 2.1A, Data Available.

APPENDIX C

PHOTOGRAPHS

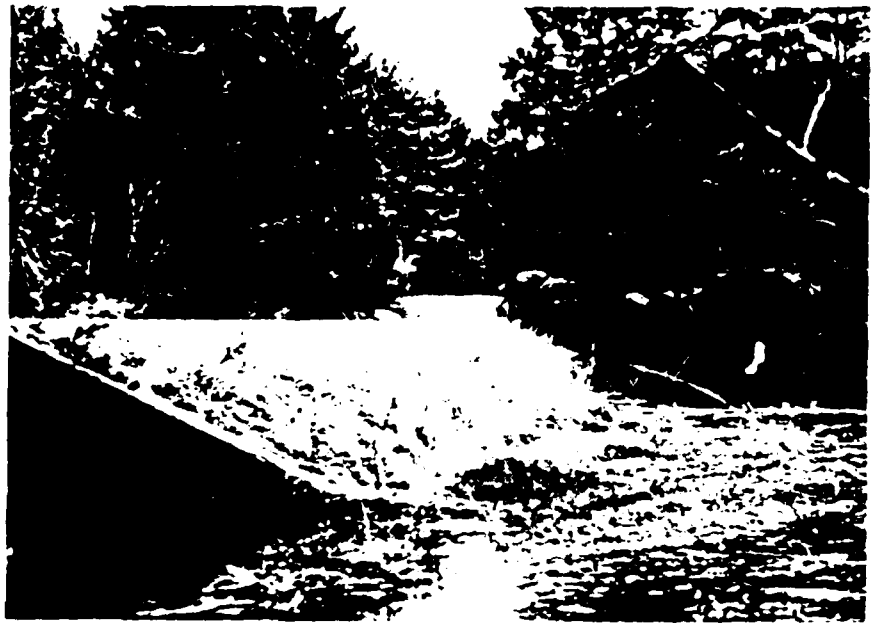


NOTE: PHOTOGRAPH LOCATION 8 NOT SHOWN

PHOTOGRAPH KEY MAP

C-1

PHOTOGRAPH 1	Overview of upstream embankment slope looking toward right abutment. Note shrub growth at toe of slope.
PHOTOGRAPH 2	Overview of dam crest looking toward right abutment.
PHOTOGRAPH 3	View of downstream slope and right abutment junction from spillway outfall. Note seep location and shrub growth at toe of slope.
PHOTOGRAPH 4	View of downstream slope and spillway - embankment junction from right abutment. Note seep location and tree growth.



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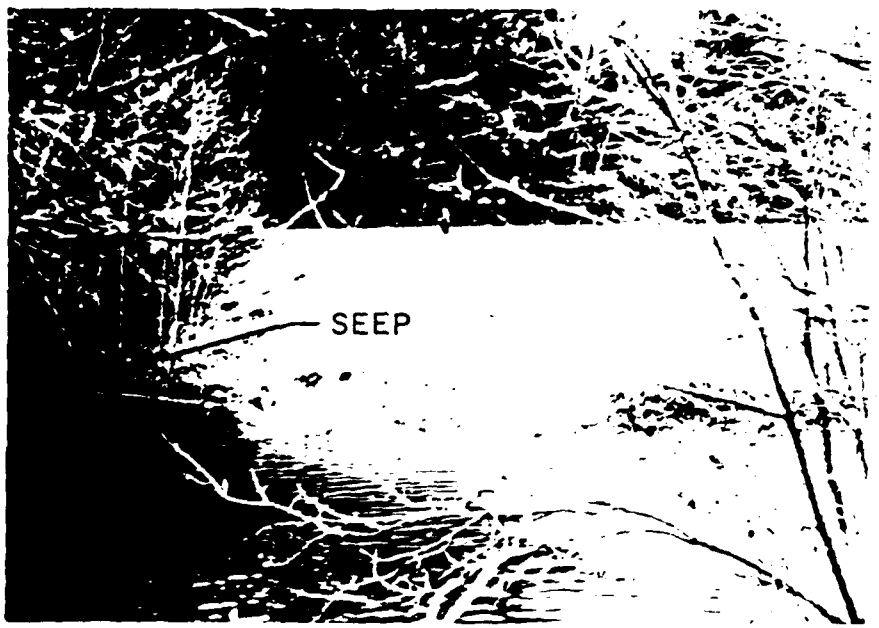
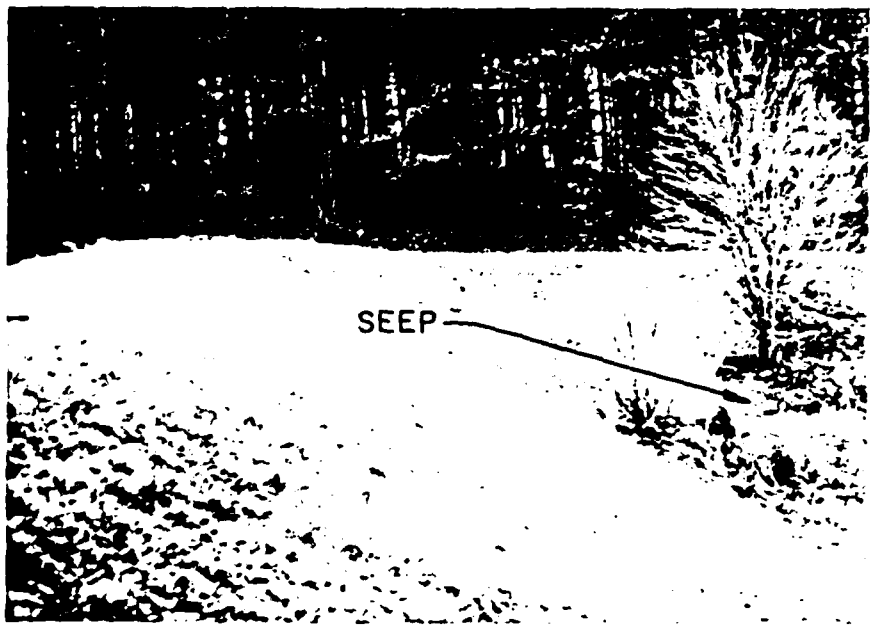


3



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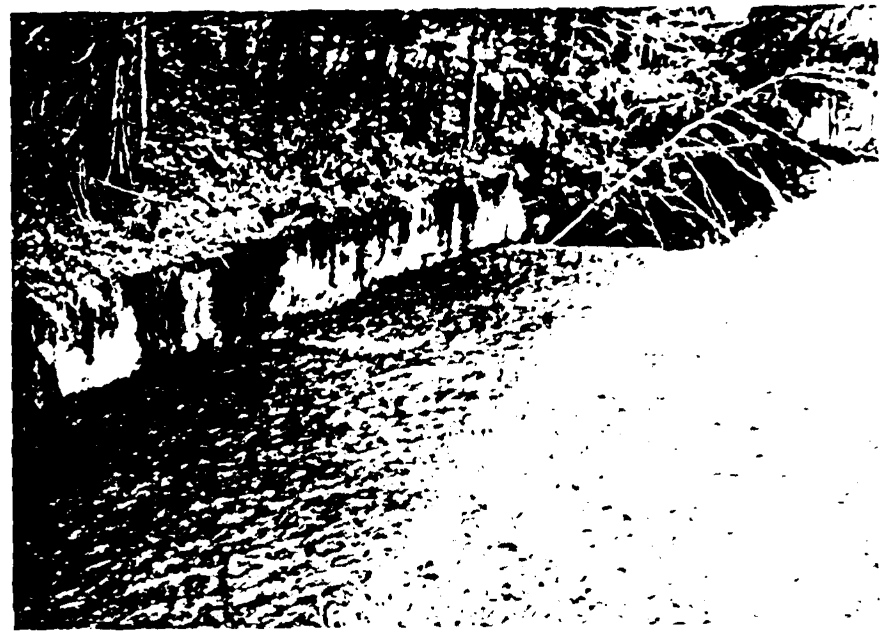
PHOTOGRAPH 5	View of spillway approach channel, apron and mid-channel section. Note cracks and spalling on concrete surfaces and tree growth along sidewall.
PHOTOGRAPH 6	View of spillway discharge channel. Note cracks in channel sidewall and bottom, and tree growth along sidewall.
PHOTOGRAPH 7	Close-up view of the right spillway sidewall end section at outfall. Note severe deterioration of concrete surface and tree growth behind sidewall.
PHOTOGRAPH 8	Downstream hazard 1.1 miles below dam.

5



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7

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2-3

APPENDIX D

HYDROLOGIC AND HYDRAULIC ENGINEERING AND COMPUTER DATA

APPENDIX D
HYDROLOGY AND HYDRAULICS

Methodology: The dam overtopping analysis was accomplished using the systemized computer program HEC-1 (Dam Safety Version, July, 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. A brief description of the methodology used in the analysis is presented below.

1. Precipitation: The Probable Maximum Precipitation (PMP) is derived and determined from regional charts prepared from past rainfall records including "Hydrometeorological Report No. " prepared by the U.S. Weather Bureau.

   The index rainfall is reduced from 10% to 20% depending on watershed size by utilization of what is termed the area reduction adjustment factor. Distribution of the total rainfall is made by the computer program using distribution methods developed by the Corps of Engineers.

2. Inflow Hydrograph: The hydrologic analysis used in development of the overtopping potential is based on applying a hypothetical storm to a unit hydrograph to obtain the inflow hydrograph for reservoir routing.

   The unit hydrograph is developed using the Snyder method. This method requires calculation of several key parameters. The following list give these parameters, their definition and how they were obtained for these analyses.

Parameter	Definition	Where Obtained
C_t	Coefficient representing variations of watershed	From Corps of Engineers *
L	Length of main stream channel	From U.S.G.S. 7.5 minute topographic map
L_{ca}	Length on main stream to centroid of watershed	From U.S.G.S. 7.5 minute topographic map
C_p	Peaking coefficient	From Corps of Engineers *
A	Watershed size	From U.S.G.S. 7.5 minute topographic map

3. Routing: Reservoir routing is accomplished by using Modified Puls routing techniques where the flood hydrograph is routed through reservoir storage. Hydraulic capacities of the outlet works, spillways and the crest of the dam are used as outlet controls in the routing.

The hydraulic capacity of the outlet works can either be calculated and input or sufficient dimensions input and the program will calculate an elevation-discharge relationship.

Storage in the pool area is defined by an area-elevation relationship from which the computer calculates storage. Surface areas are either planimetered from available mapping or U.S.G.S. 7.5 minute series topographic maps or taken from reasonably accurate design data.

4. Dam Overtopping: Using given percentages of the PMF the computer program will calculate the percentage of the PMF which can be controlled by the reservoir and spillway without the dam overtoppping.

* Developed by the Corps of Engineers on a regional basis for Pennsylvania.

HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Predominately forest and open field, little rural development.

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1139.0 (42 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 1143.9 (82 acre-feet)

ELEVATION MAXIMUM DESIGN POOL: 1142.0 feet

ELEVATION TOP DAM: 1143.9 feet

EMERGENCY SPILLWAY

a. Elevation Spillway control apron El. 1139.0.
b. Type Concrete lined rectangular channel.
c. Width 35 feet at dam centerline.
d. Length 100 feet.
e. Location Left abutment.
f. Number and Type of Gates None.

OUTLET WORKS

a. Type 18 inch diameter cast iron pipe.
b. Location 50 feet from right abutment.
c. Entrance Invert El. 1127+
d. Exit Invert El. 1125+
e. Emergency Drawdown Facilities None

HYDROMETEOROLOGICAL GAGES

a. Type None
b. Location
c. Records

MAXIMUM NON-DAMAGING DISCHARGE Est. 1177 cfs (existing conditions)

HEC-1-DAM SAFETY VERSION
HYDROLOGY AND HYDAULIC ANALYSIS
DATA BASE

NAME OF DAM:	Greenville Dam No. 3 NDI ID. No. PA 01081
Probable Maximum Precipitation (PMP)	23.2 inch *(unadjusted)
Drainage Area	2.2 sq. mi.
Reduction of PMP Rainfall for Data Fit Reduce by 20% therefore PMP rainfall =	 18.6 inch
Adjustments of PMF for Drainage Area 6 hrs. 12 hrs. 24 hrs. 48 hrs.	 117% 127% 141% 151%
Snyder Unit Hydrograph Parameters Zone C_p C_t L L_{ca} $t_p = 2.7(L \times L_{ca})^{0.3}$	 27 0.40 2.7 2.48 mile 1.68 mile 4.14 hour
Loss Rates Initial Loss Constant Loss Rate	 1.0 in. 0.05 inch/hour
Basic Flow Generation Parameters Flow at Start of Storm Base Flow Cutoff Recession Ratio	 1.5 cfs/sq. mi. 0.05 Qp 2.0
Spillway Channel Data Crest Length Freeboard Discharge Coefficient Exponent Discharge Capacity Design Est.	 35 feet 4.9 feet 3.1 1.5 (3 feet head) 660 cfs (4.9 feet head) 1177 cfs

*Hydrometerological Report 33
**Hydrological zone defined by Corps of Engineers, Baltimore District, for determining Snyder's Coefficients (Cp and C).

GREENVILLE DAM NO. 3
ELEVATION - AREA - CAPACITY RELATIONSHIPS

1. Reservoir surface areas obtained by planimeter of contours on 7.5 minute quadrangle map and drawing prepared by Chester & Fleming Consulting Engineers.

2. Elevation where area equals zero:

   Area = 0 @ Elevation 1122 - Obtained from Chester & Fleming Consulting Engineers, drawing 694-15.

3. Storage capacity computed using:

   $\Delta Vol. = \frac{h}{3} (A_1 + \sqrt{A_1 A_2} + A_2)$

   Where $h = WSEL_2 - WSEL_1$

WSEL (feet)	h (feet)	Area (acres)	ΔVol (acre-feet)	Storage Vol. (acre-feet)
1122		0		0
	2		0.7	
1124		1		1
	15		41.2	
1139		5		42
	5		41.2	
1144		12		83
	6		83.7	
1150		16		167

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  26 FEB 79
**********
    1               A1      NON-BREACH ANALYSIS OF DAM NO. 3
    2               A2      LITTLE SHENANGO CREEK, BOROUGH OF GREENVILLE
    3               A3      50 PERCENT PMF - UNIT HYDROGRAPH BY SNYDER METHOD
    4               B    300       0      30       0       0       0       0       0      -4
    5               B1     5
    6               J      1       5       1
    7               J1   0.2     0.3     0.4    0.45     0.5
    8               K      0    LAKE                                      1
    9               K1      INFLOW HYDROGRAPH FOR DAM NO.3
   10               M      1       1     2.2                         0                      1
   11               P            23.2     117     127     141     151
   12               T                                                1.0    0.05
   13               W   4.14    0.40
   14               X   -1.5   -0.05     2.0
   15               K      1     DAM                                 1
   16               K1      MOD PULS ROUTING OF FLOW THROUGH DAM NO. 3 SPILLWAY
   17               Y                                  1       1
   18               Y1     1                                        42
   19               $S     0     0.7      42      83     167
   20               $E  1122    1124    1139    1144    1150
   21               $$  1139      35     3.1     1.5
   22               $D1143.9    3.08     1.5     180
   23               K      99
   24               A
   25               A
   26               A
   27               A
   28               A


PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

         RUNOFF HYDROGRAPH AT        LAKE
         ROUTE HYDROGRAPH TO          DAM
         END OF NETWORK
```

```
**********
F' ^OD HYDROGRAPH PACKAGE (HEC-1)
     SAFETY VERSION     JULY 1978
  LAST MODIFICATION  26 FEB 79
**********

RUN  DATE: 16 APR 81
RUN  TIME: 12. 3.31
```

NON-BREACH ANALYSIS OF DAM NO. 3
LITTLE SHENANGO CREEK, BOROUGH OF GREENVILLE
50 PERCENT PMF - UNIT HYDROGRAPH BY SNYDER METHOD

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	30	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 5 LRTIO= 1
RTIOS= 0.20 0.30 0.40 0.45 0.50

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH FOR DAM NO.3

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
LAKE	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	2.20	0.0	2.20	0.0	0.0	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.0	23.20	117.00	127.00	141.00	151.00	0.0	0.0

TRSPC COMPUTED BY THE PROGRAM IS 0.800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.0	0.0	1.00	0.0	0.0	1.00	1.00	0.05	0.0	0.0

UNIT HYDROGRAPH DATA
TP= 4.14 CP=0.40 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -0.05 RTIOR= 2.00

UNIT HYDROGRAPH 87 END-OF-PERIOD ORDINATES, LAG= 4.16 HOURS, CP= 0.40 VOL= 1.00

18.	38.	61.	86.	108.	126.	136.	139.	133.
124.	117.	109.	102.	96.	90.	84.	79.	74.	70.
65.	61.	57.	54.	50.	47.	44.	41.	39.	36.
34.	32.	30.	28.	26.	25.	23.	22.	20.	19.
18.	17.	16.	15.	14.	13.	12.	11.	11.	10.
9.	9.	8.	8.	7.	7.	6.	6.	6.	5.
5.	5.	4.	4.	4.	4.	3.	3.	3.	3.
3.	2.	2.	2.	2.	2.	2.	2.	2.	1.
1.	1.	1.	1.	1.	1.	1.			

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
		SUM	28.03	25.59	2.43	72604.
			(712.)(	650.)(	62.)(	2055.92)

HYDROGRAPH ROUTING

MOD PULS ROUTING OF FLOW THROUGH DAM NO. 3 SPILLWAY

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
DAM	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.0	0.0	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.0	0.0	0.0	42.	0

CAPACITY=	0.	1.	42.	83.	167.
ELEVATION=	1122.	1124.	1139.	1144.	1150.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1139.0	35.0	3.1	1.5	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1143.9	3.1	1.5	180.

: OUTFLOW IS 541. AT TIME 44.50 HOURS

PEAK OUTFLOW IS 813. AT TIME 44.50 HOURS

PEAK OUTFLOW IS 1084. AT TIME 44.50 HOURS

PEAK OUTFLOW IS 1226. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 1358. AT TIME 44.00 HOURS

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 0.20	RATIO 2 0.30	RATIO 3 0.40	RATIO 4 0.45	RATIO 5 0.50
ROGRAPH AT	LAKE	2.20	1	546.	819.	1092.	1229.	1366.
		(5.70)	(	15.47)(	23.20)(	30.93)(	34.80)(	38.67)(
ROUTED TO	DAM	2.20	1	541.	813.	1084.	1226.	1358.
		(5.70)	(	15.33)(	23.02)(	30.69)(	34.71)(	38.46)(

SUMMARY OF DAM SAFETY ANALYSIS

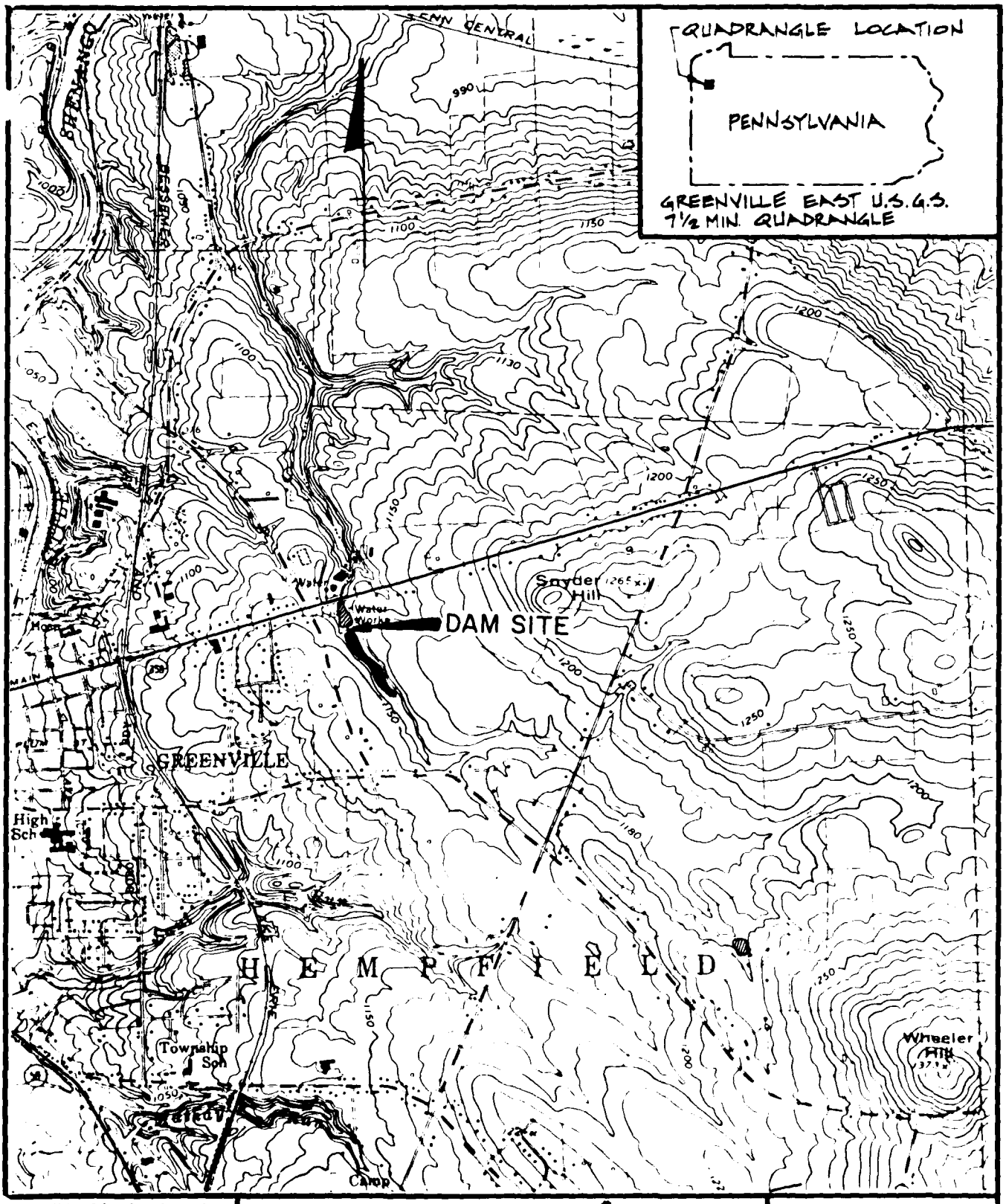
	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1139.00	1139.00	1143.90
STORAGE	42.	42.	82.
OUTFLOW	0.	0.	1177.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.20	1141.92	0.0	66.	541.	0.0	44.50	0.0
0.30	1142.83	0.0	73.	813.	0.0	44.50	0.0
0.40	1143.64	0.0	80.	1084.	0.0	44.50	0.0
0.45	1143.99	0.09	83.	1226.	2.00	44.00	0.0
0.50	1144.18	0.28	85.	1358.	3.50	44.00	0.0

APPENDIX E

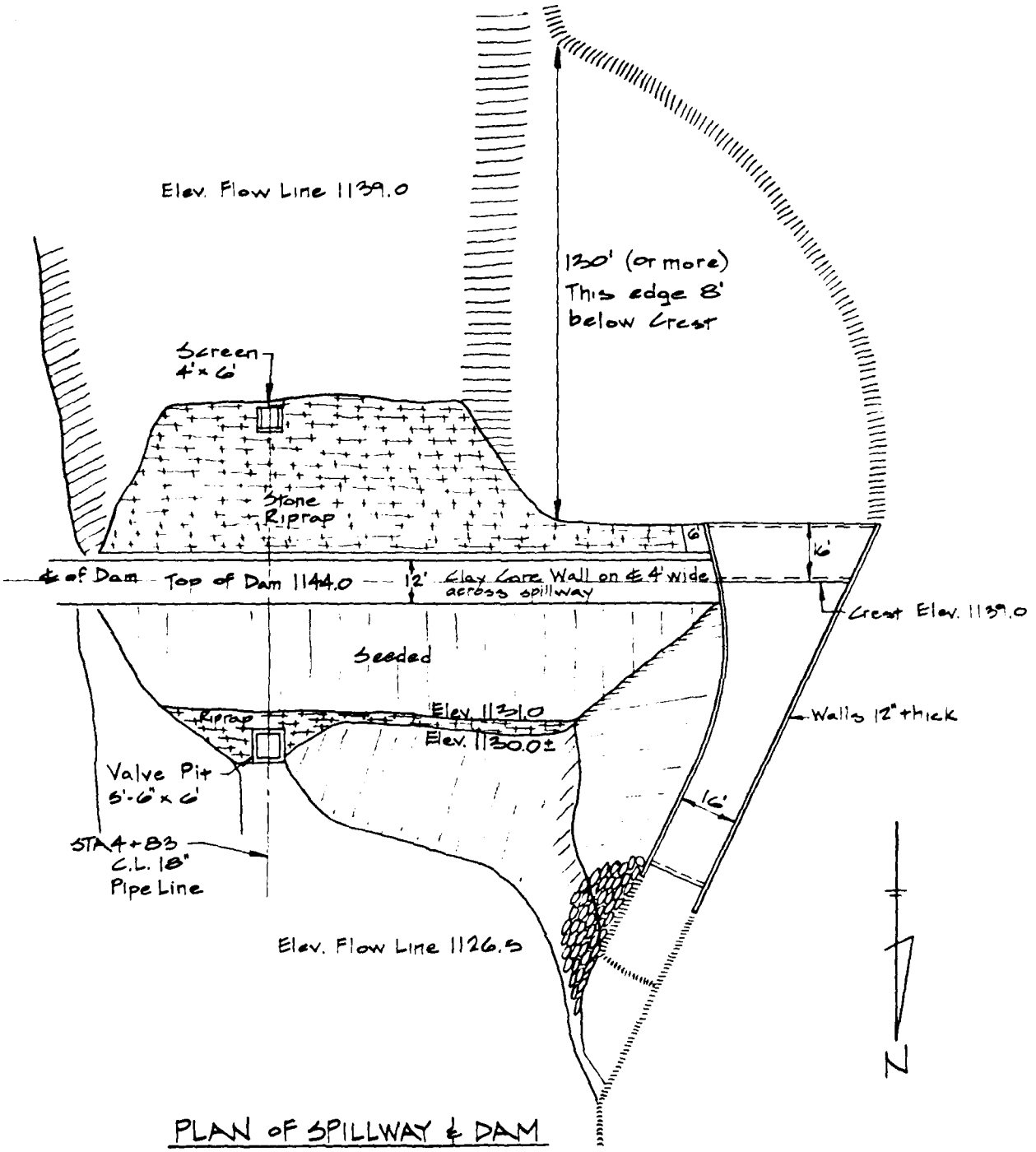
LOCATION PLAN AND PLATES

LIST OF PLATES



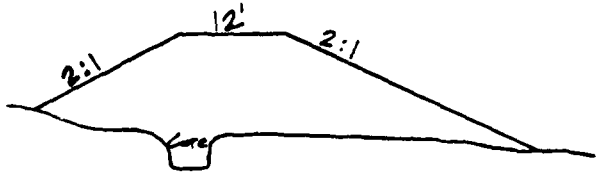
DATE: MARCH 3, 1981	GREENVILLE DAM #3 NATIONAL DAM INSPECTION PROGRAM	LOCATION PLAN
SCALE: 1" = 2000'		
DR: JLM CK: TED	ACKENHEIL & ASSOCIATES CONSULTING ENGINEERS PITTSBURGH, PA., CHARLESTON, W. VA. & BALTIMORE, MD.	
DWG. NO. E 1		

This sketch was taken from GREENVILLE WATER CO. SKETCH OF SPILLWAY & DAM FOR RESERVOIR No 3
CHESTER & FLEMING CONSULTING ENGINEERS
UNION BANK BLD. PITTSBURGH PA OCT 16, 1913
20-5

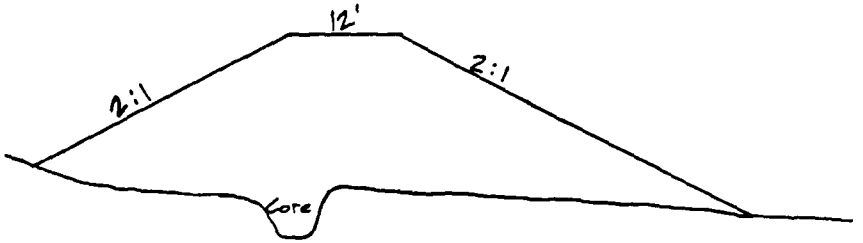


PLAN OF SPILLWAY & DAM
RESERVOIR No 3 SCALE 1"=40'

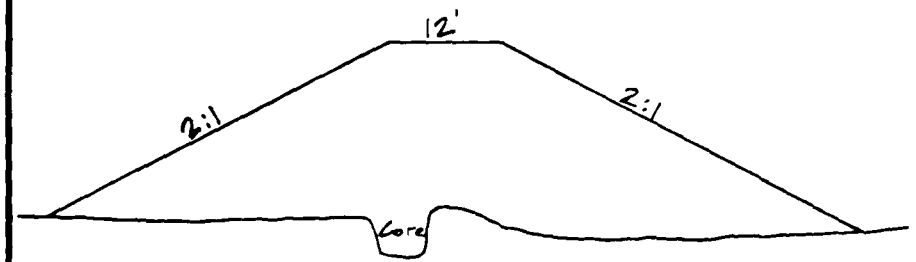
PLATE NO. 1



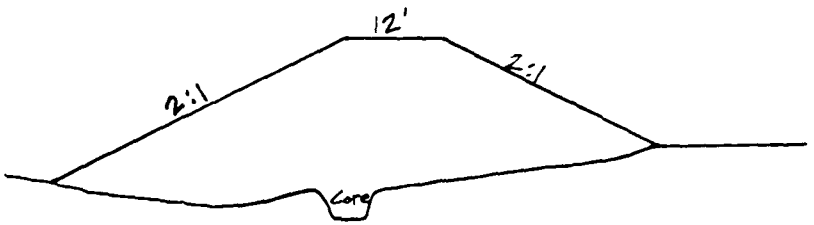
STATION 3+80



STATION 4+17



STATION 4+83



STATION 5+23

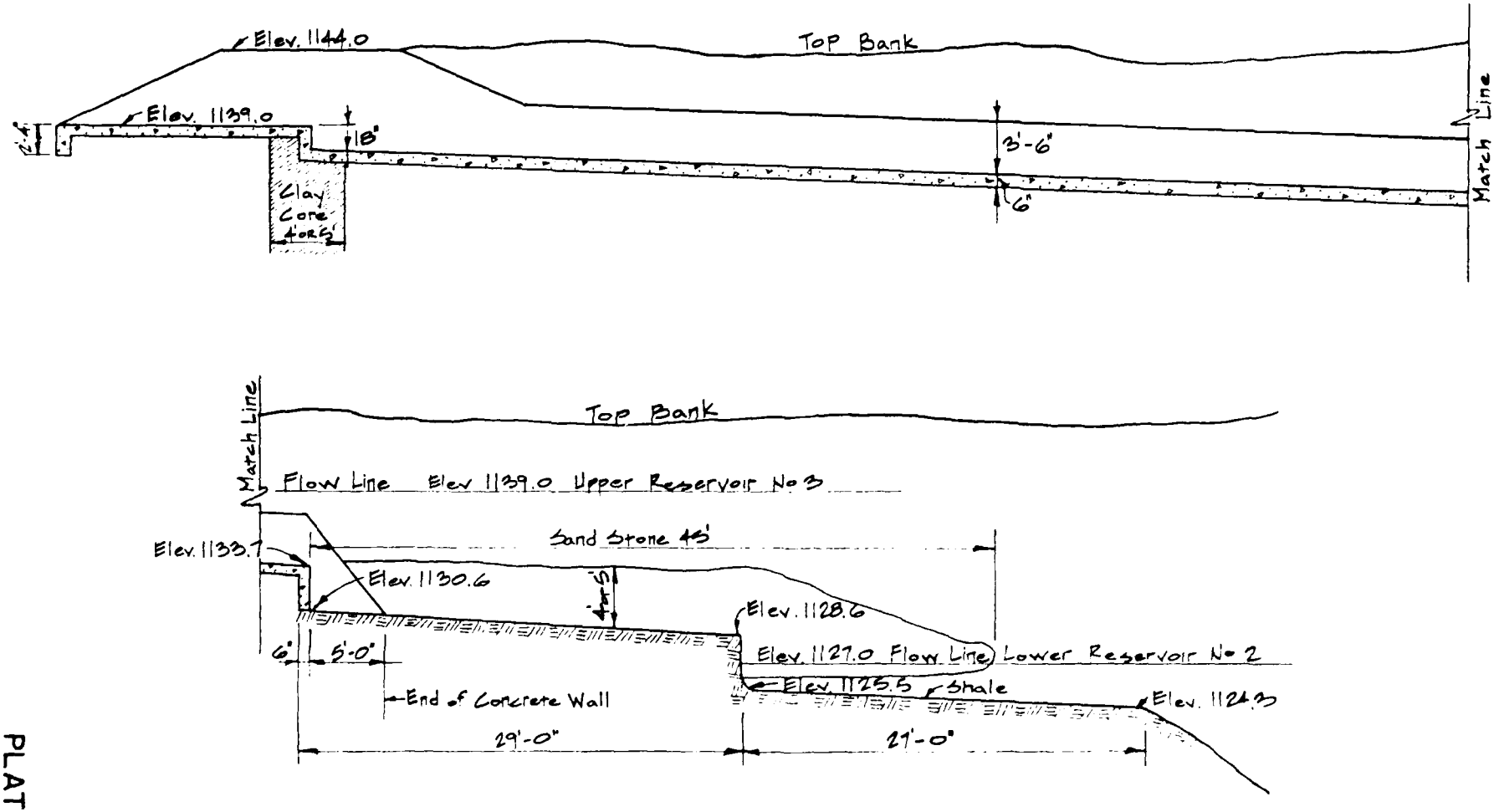
PLATE NO. 2

CROSS SECTIONS SHOW EARTH CONSTRUCTION

1"=10'

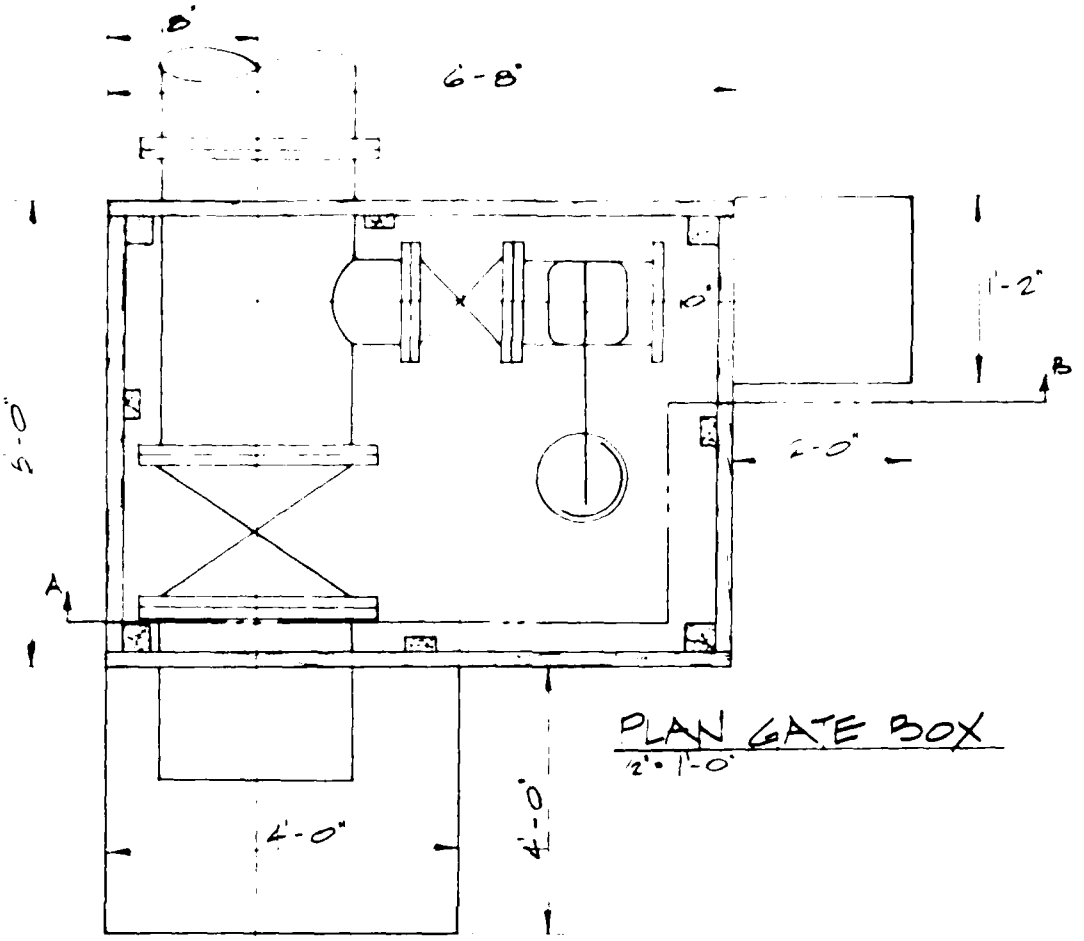
This sketch was taken from GREENVILLE WATER CO. GENERAL PLAN DAM No. 3 SHEET No. 6 SCALE = 1"=20'
CHESTER & FLEMING CONSULTING ENGINEERS PITTSBURGH PA. JUNE 23, 1913 20-3

This sketch was taken from; GREENVILLE WATER CO SKETCH OF SPILLWAY & DAM FOR RESERVOIR NO
CHESTER & FLEMING CONSULTING ENGINEERS UNION BANK BLD PITTSBURGH PA.
OCT. 16, 1913 20-5

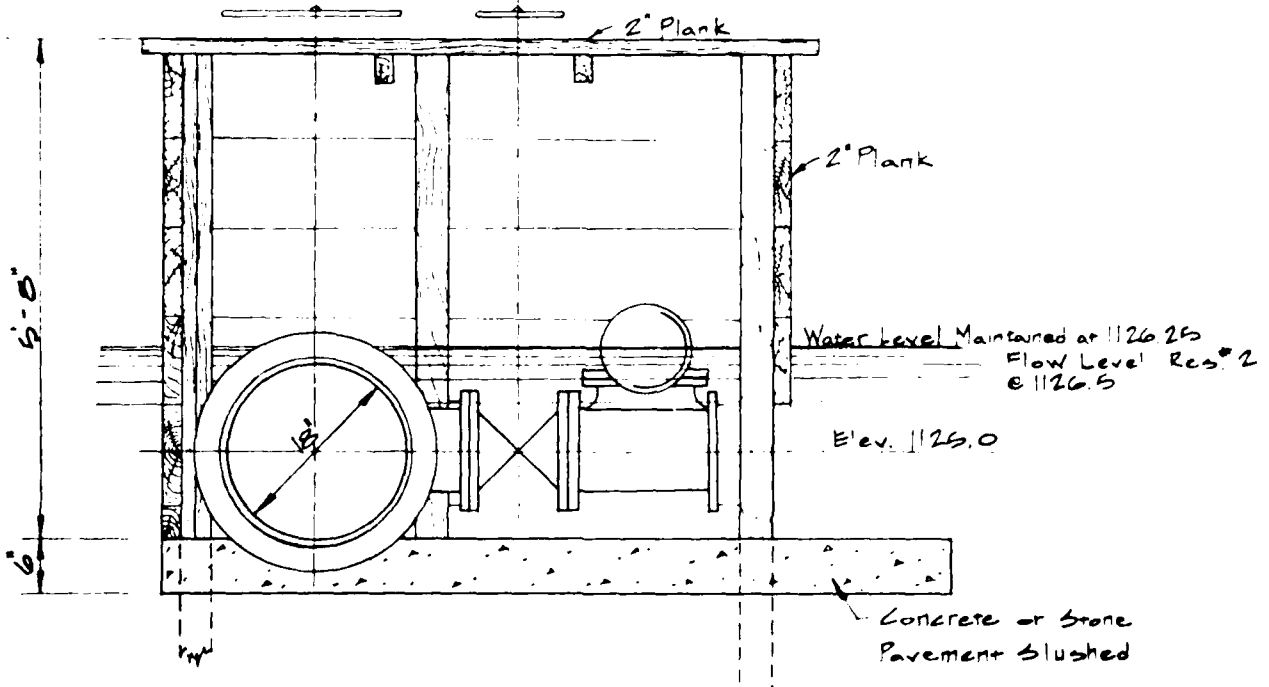


ELEVATION OF WEST WALL
SCALE 1"=10'

PLATE NO. 3

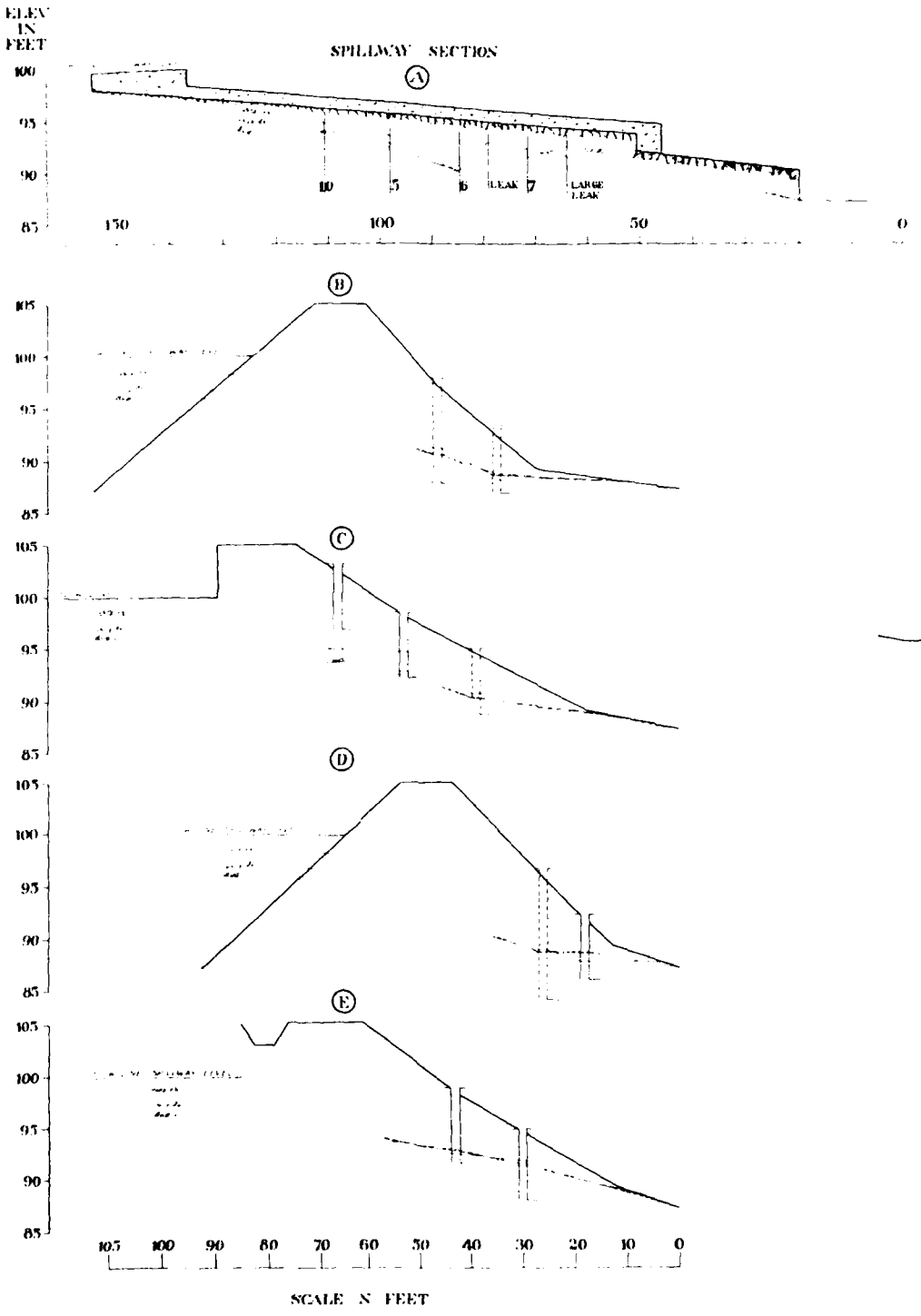


PLAN GATE BOX
1/2" = 1'-0"



SECTION AB - GATE BOX
1/2" = 1'-0"

This sketch was taken from: GREENVILLE WATER CO. CONSTRUCTION OF RESERVOIR #3 DETAILS
CHESTER & FLEMING CONSULTING ENGINEERS PITTSBURGH PA.
SHEET NO 5 MAY 5 1913 20-4 PLATE NO. 4


ELEV IN FEET
SPILLWAY SECTION
A
100
95
90
85
150
100
50
0
10
5
6
LEAK
7
LARGE LEAK
B
C
D
E
105
100
95
90
85
105
100
90
80
70
60
50
40
30
20
10
0
SCALE IN FEET

RESERVOIR
SPILLWAY AREA
CREST OF SPILLWAY

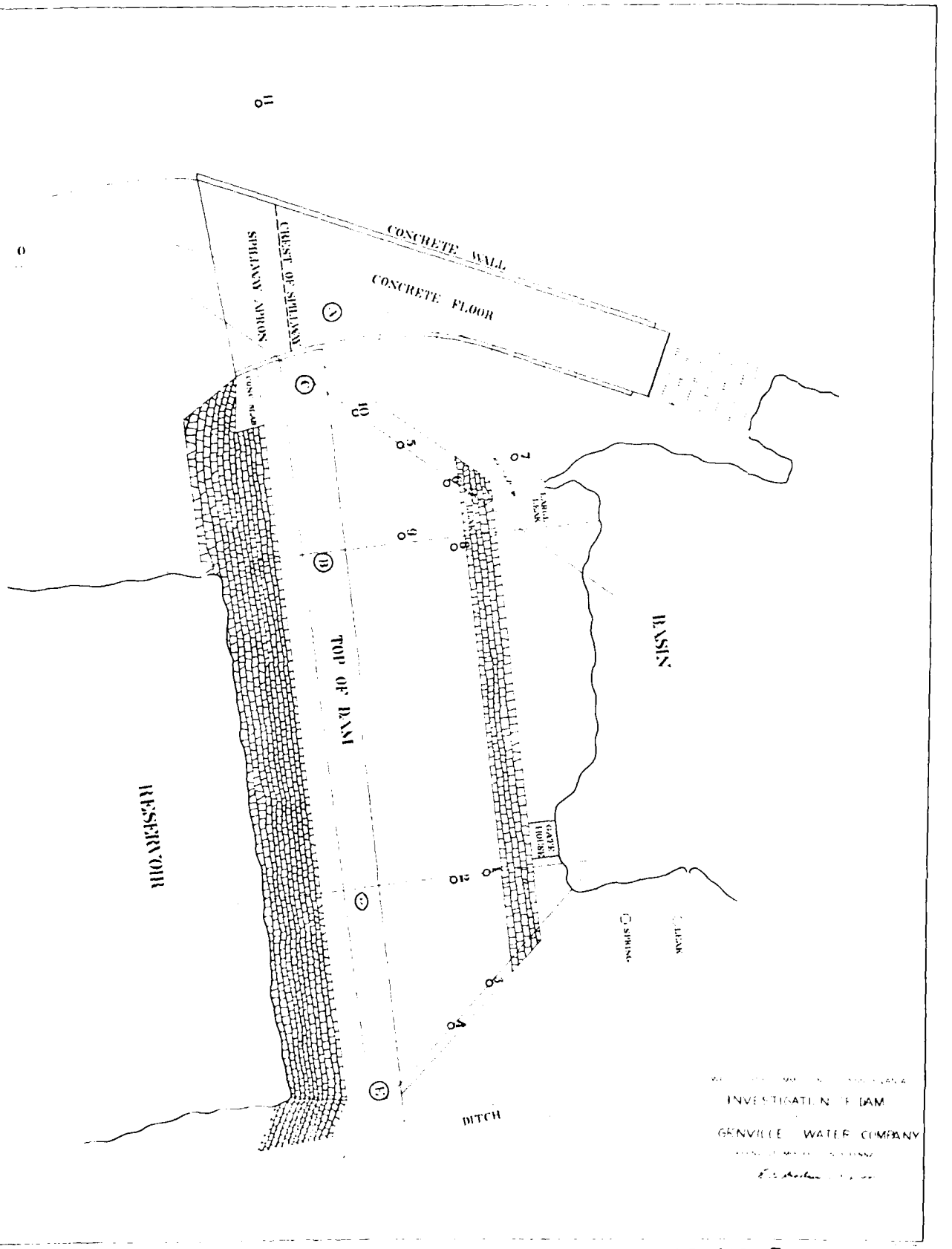

CONCRETE WALL
CONCRETE FLOOR
CREST OF SPILLWAY
SPILLWAY APRON
TOP OF DAM
RESERVOIR
BASIN
DITCH
INVESTIGATION OF DAM
GREENVILLE WATER COMPANY

PLATE NO. 5

APPENDIX F

REGIONAL GEOLOGY

GREENVILLE DAM NO. 3
NDI ID. NO. PA 01081
REGIONAL GEOLOGY

REGIONAL GEOLOGY

Greenville Dam No. 3 is located in the Allegheny Plateau Physiographic Province. The dam is situated on the lower member Mississippian Shenango Formation which is overlain by approximately 10 feet of post glacial alluvium from the Kent ice sheet (Wisconsinian Stage). The Mississippian Meadville shale contact is located approximately 400 feet north of the dam.

The lower member of the Shenango Formation is composed of medium to fine-grained light-gray sandstone and medium to dark gray shale and siltstone. The Meadville shale is a medium to dark gray shale with siltstone, and lenses of fine-grained sandstone and occasional thin beds of limestone.

The strike of the bedding is generally east-west and the dip generally north about 7 to 16 feet per mile.

SITE GEOLOGY

No subsurface investigation was performed at the dam site. Records indicate the dam rests on stiff clay and shale. Sandstone was reportedly encountered during excavation of spillway channel.

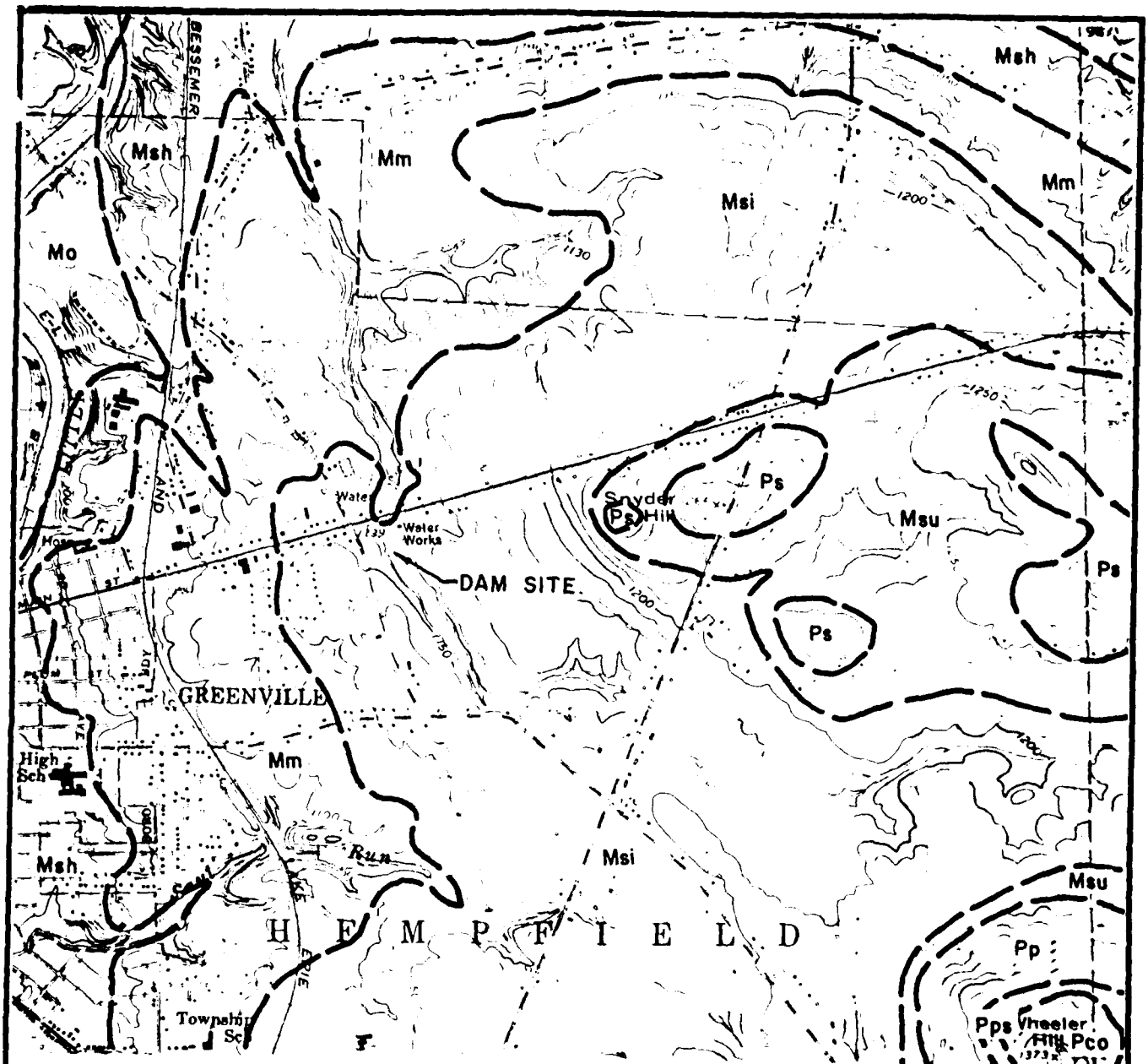
SITE GEOLOGY LEGEND

Pco - Connoquenessing Formation
Ps - Sharon Formation
Pp & Pps - Pottsville Formation
Msu - Shenango Formation (Upper Member)
Msi - Shenango Formation (Lower Member)
Mm - Meadville Shale
Msh - Sharpsville Sandstone
Mo - Orangeville Shale

References

Engineering Characteristics of the Rock of Pennsylvania, McGlade, Geyer and Wilshusen, Pennsylvania Geological Survey, 1972.

Schiner, George R. and Kimmel, Grant E. 1976, Water Resource Report 33, Commonwealth of Pennsylvania Department of Environmental Resources, Bureau of Topographic and Geologic Survey.



GREENVILLE EAST QUADRANGLE MERCER COUNTY, PENNSYLVANIA

SCALE: 0 ——— 1/2 MILE 1:24000

CONTOUR INTERVAL 10FT. DATUM IS MEAN SEA LEVEL

N

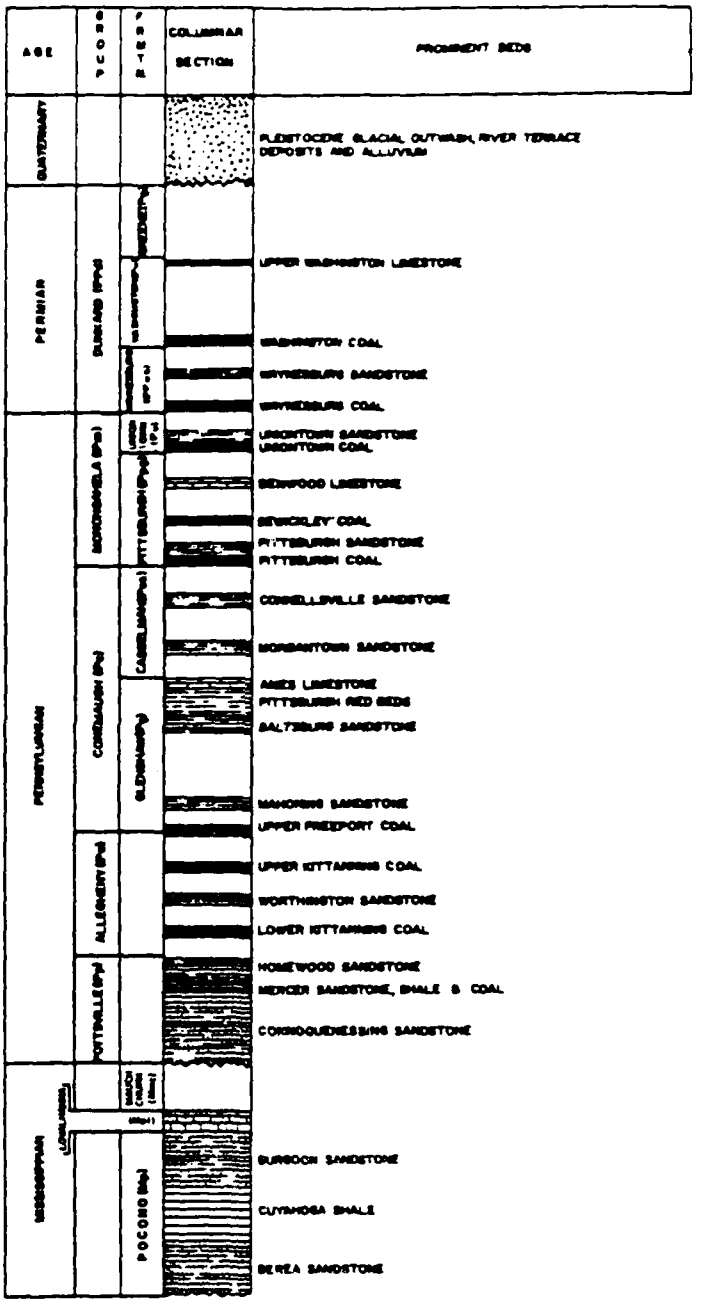
——— ——— ——— FORMATION CONTACT

FOR FORMATION LEGEND SEE PAGE F1

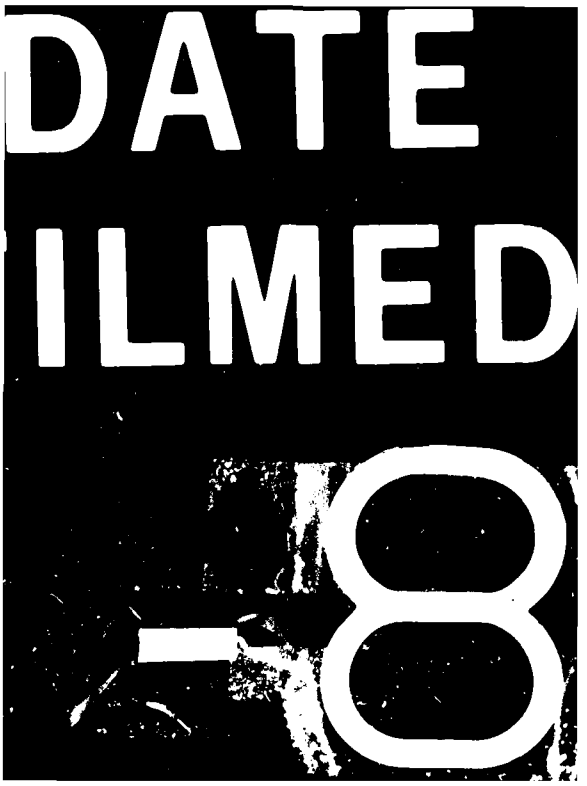
DATA OBTAINED FROM PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL RESOURCES, TOPOGRAPHIC AND GEOLOGIC SURVEY, 1976 WATER RESOURCE REPORT 33.

DATE: MARCH 3, 1981	GREENVILLE DAM #3 NATIONAL DAM INSPECTION PROGRAM	GEOLOGIC MAP
SCALE: 1"= 2000		
DR: JLM CK: TED	ACKENHEIL & ASSOCIATES CONSULTING ENGINEERS PITTSBURGH, PA., CHARLESTON, W. VA. & BALTIMORE, MD.	
DWG. NO. F2		

DATAPRINT



DATE: MARCH 3, 1981	GREENVILLE DAM #3 NATIONAL DAM INSPECTION PROGRAM		GEOLOGIC COLUMN
SCALE: None			
DR: AP CK: JEB	ACKENHEIL & ASSOCIATES CONSULTING ENGINEERS GEO SYSTEMS, INC 1000 BANKSVILLE RD / PITTSBURGH PA 15216		
F 3			


DATE
ILMED
-8